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# Radiation Research and the Future of Radiotherapy[1]

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PRESIDENTIAL addresses are often a dreaded experience both for outgoing presidents, who cudgel their brains to prepare them, and for the members who must listen to them. Ideally, such an address is concerned with the president's own scientific contributions, together with his mature speculations as to their significance. His work, however, has usually been published and adequately reviewed at symposia, conferences, or panel discussions. Under such circumstances, he is likely to feel abashed at the thought of inflicting this material yet again upon his captive member-audience. If he is to philosophize instead, a president must speak of matters which he understands well and which concern him deeply and personally. I have chosen to put before you tonight my appraisal of the present status and potentialities of research in the field of clinical radiation therapy.

First, it seems proper to look at the positive aspects of the situation. Radiotherapy has existed as a clinical field for a scant sixty years. In that time, it has taken its place squarely alongside of surgery as a standard means of treating cancer. Cure rates have been steadily pushed upwards, until today over one-third of cancers at all sites and in all stages are amenable to cure or long-term survival. Meanwhile, the frequency of severe reactions, radiation sickness, and late radiation injuries has been effectively reduced.

The radiotherapist must have a thorough working knowledge of the clinical behavior, the radioresponsiveness, and the prognosis of a host of tumors differing as to site of origin, histologic pattern, and rate of growth. He must also have some comprehension of clinical radiation physics, and be able to select the treatment technic which most selectively concentrates radiation in the tumor volume, taking pains to minimize damage to nearby sensitive structures. It is important to realize that he is already stretched thin in bridging the gap between clinical medicine and radiation physics. With this realization, it is possible to understand and to sympathize with his relatively limited grasp of a third essential discipline, radiobiology. Although the need to stretch still further to embrace radiobiology will receive most of my attention, I should like to place American radiotherapy in better perspective by dwelling first on some of its other significant problems.

In England and on the Continent, it has been clearly recognized for years that radiotherapy and diagnostic roentgenology are bound together only by a common physical agent, and that mastery of either field alone is a sufficient achievement for the would-be radiologist, who must there-

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fore make a firm choice early in his training. Therapeutic and diagnostic groups abroad are almost invariably set up as separate departments, with separate budgets, staffs, and physical facilities. Therapy centers exist in all the large urban areas, and patients with cancer are funneled to these centers for treatment. In America, a number of factors have strongly impeded efforts to bring about a similar situation. The vastness of our geography makes it extremely difficult, expensive, and time-consuming to transport patients from remote areas to large cities for therapy. Since many small communities can support the services of one or more diagnostic roentgenologists, it has been both practical and traditional for these diagnosticians to care for the community's small load of radiotherapy material as well, referring to the urban centers only the more difficult or recurrent cases.

This state of affairs creates three major problems for American radiologists. First, it has forced us to provide a hybrid form of training for our residents, in which anywhere from six months to one year or so of their three-year program is devoted explicitly to radiotherapy. This is inadequate to give them the breadth of experience they really require for a career in radiotherapy alone; it is designed to meet the needs of smaller communities for the jack-of-all-trades in radiology. It is obvious that both diagnostic and therapeutic training must suffer in such hybrid programs.

Secondly, a subtle difficulty confronts the young radiologist who wishes to practice general radiology. Let us assume that by extraordinary diligence, or perhaps by the investment of an additional year, he has acquired a quite respectable grasp of clinical radiotherapy, as well as of roentgen diagnosis. After he opens an office or starts work in a hospital in a small community, the number of cancer patients referred to him for radiotherapy will be remarkably small, simply because the overall cancer morbidity rate is about 300 cases per 100,000 population per year, and only a fraction of these will be referred for radiotherapy. As the years go by, therefore, he is likely to do so little radiotherapy, except for the palliation of obviously hopeless cases, that both his skill and his interest in the field will tend to diminish.

At the same time, the small volume of therapeutic work handled by each general radiologist has the aggregate effect of siphoning off curable cancer cases from the radiotherapy centers of the larger cities, creating a third difficulty, namely, that few centers in our country see a large volume of curable cancer of all types. It is obvious that randomization of cases among various treatment groups is the only way by which definitive answers to many clinical problems in radiotherapy can be obtained. However, the inadequacy of patient numbers in any one institution has been a serious deterrent to the establishment of statistically valid studies.

In the setting of this geographic, economic, and organizational log-jam, it becomes easy to understand the firm grasp in which radiotherapy is held by empiricism. Since he is really not in a position to subject many questions to rigorous testing and proof, the radiotherapist comes increasingly to rely on "clinical judgment," trial and error, and past experience. He continues to compile his treatment results, in terms of five- and ten-year survivals of various forms of cancer, resigned to the knowledge that the comparability of his data with that of others, or even with his own previous experience, will always be open to serious doubt.

So much for some of the trials and tribulations of radiotherapy at the clinical level. I have presented them only as the background for another important aspect of the total problem. No field of human inquiry can stand still, can stop asking and attempting to answer serious questions, without slowly sliding backward into oblivion as competing fields advance. The most important questions that confront the radiotherapist can be attacked only by *research;* it is therefore pertinent for us to examine what role research has had to date, and

seems likely to have in this field in the years to come. As with any generalization, the picture that I shall present has certain limitations and inaccuracies, and is to be taken simply as a panoramic description.

During the twenty-year period from about 1910 to 1930, the dominant element in radiotherapeutic research was radiobiology. This will perhaps come as a surprise to some of the younger group, who may have acquired the notion that radiobiologic research had its birth during World War II. At the other extreme, some older radiotherapists have expressed the conviction that all of the significant experimental problems of radiotherapy were examined and satisfactorily solved by the radiologists of that earlier era. Certainly, the experimental foundations of today's radiotherapy rest on the classical contributions of Regaud, Lacassagne, Heineke, Schwarz, Holzknecht, and many other pioneers, although their work was seriously hampered by the lack of a convenient and reproducible physical unit and by the primitiveness of their experimental materials. One might have thought that it would have gained great impetus, therefore, when the roentgen was finally introduced in 1929, replacing the skin erythema unit and chemical pastilles on which dose estimation had depended until then.

By some quirk, however, interest among clinical radiotherapists seems to have been diverted into the new channel of radiation physics; many departments abandoned radiobiology and turned to dosimetry and the development of radiation apparatus of higher energy. This is not to say that research in radiobiology vanished during the 1930's and early 1940's; though abandoned by the clinicians, it was carried on vigorously by the biologists and the physicists; and some of the keystones of the subject were contributed during those years by such men as Lea, Gray, Cramer, Zirkle, Packard, and Mottram, to mention but a few. Nonetheless, it is fair to say that radiation physics has remained the major area of research interest among clinical radiotherapists in the years since 1930; from it have come many refinements in treatment, including precise beam-alignment technics, detailed isodose mapping of tumors and their surrounding tissues, the use of bolus material, wedge filters, etc. Whether these innovations have been responsible for any real improvement in cure rates is difficult to determine; they have certainly reduced the hazard of radiation injuries by eliminating "hot spots" in the treated tissues and have permitted therapeutic dose levels to be inched safely upward over the years. Emphasis on isodose mapping and on "treatment planning" has been strongest in certain radiotherapeutic centers in England and the Scandinavian countries, and for some years now these have been the fashionable Meccas to which many of our young radiotherapists have flocked to put the final high gloss on their training.

Some of these young men, lacking experience and perspective, have come to equate "research" with the remeasurement to three decimal places of dose distribution patterns hitherto known to two decimal places, losing sight of the fact that such patterns may then be applied to the treatment of tumors whose exact anatomical limits may not be clinically measurable to within three centimeters. In a kind of wishful thinking, which is readily understandable, they have sought to create for themselves an illusion of scientific progress by making more precise that aspect of the treatment process which was already its most precise element, meanwhile neglecting as inconvenient and disturbing the glaring crudity of our methods for tumor diagnosis and delineation and the vagaries and paradoxes of the biological behavior of tumors.

It should not be necessary to remind radiotherapists that cancer is a biological problem, that its destruction by radiation is a biological response, and that the disease and its treatment are therefore to be comprehended in biological terms. Yet, although many give lip service to this view, one has only to look at our training and accreditation programs in radiotherapy to

see how obscure a role has been assigned to radiobiology.

It is almost routine for our residents to learn to calibrate x-ray machines, to measure depth doses, and to plot isodose curves; and all of them virtually memorize certain texts in radiation physics because they can expect to be quizzed on this material in their specialty board examinations. In contrast, how many residents have ever been asked to run even the simplest of radiobiologic experiments, such as the determination of an LD 50 for mice, or the comparative response of a transplanted tumor to a given dose of x-rays fractionated in various ways? I know of no department in this country where this type of exercise has been in force, and the reading which residents are stimulated to do in radiobiology and cancer biology is generally negligible. Consistent with this state of affairs is the fact that questions relative to these fundamental fields are seldom asked in the specialty board examinations and, although one of the examiners is a trained physicist, no radiobiologists are represented on the specialty examining board.

Research in radiobiology has led to exciting and important discoveries in the past decade, and the subject continues to unfold in a fascinating way. But what have those of us who are clinical radiotherapists actually contributed to radiobiologic research, from which we have so much to gain? The answer is that, with few exceptions, this progress has been made by others: by biologists, physiologists, biophysicists, geneticists, biochemists, physicists, hematologists, etc. The radiotherapist has clearly assumed little responsibility for conducting or even familiarizing himself with research in this field, to which his own clinical future seems to be so clearly linked.

I should like to hope that we may now be jolted out of our lethargy to constructive action. Following the lead which many departments of medicine and surgery have set, we must provide facilities and time for laboratory exercises and investigations in radiobiology by our residents, possibly at the expense of some time currently devoted to radiation physics, preferably not through further dilution of their clinical training. If necessary, the total time allotted for training should be extended, with the formal approval of the American Board of Radiology. Readings, discussions, seminars, and conferences on radiobiologic topics should be incorporated into the training program, and courses in these subjects should be offered at our national meetings. The American Board of Radiology should lend force to this process by introducing questions about radiobiologic fundamentals into its therapy examination and by the appointment of specially qualified examiners in this field.

On the research side, there is much to be done along a number of avenues of approach. Time does not permit a detailed analysis and description of these; instead, a brief enumeration of a few promising lines will be attempted. I do not mean to imply that the clinical radiotherapist must master and pursue all of these. He should, however, do some investigative work personally, along whatever line his interests, training, and facilities may indicate, and he should promote the appointment of a research staff in his department, working on some of the relevant biological or biochemical approaches. To such a staff, he should lend the guidance and orientation of his clinical experience with malignant disease and, in turn, he should seek to learn the rudiments of their technics and observations and to absorb from them the spirit of experimental scientific method.

The field of cell physiology should obviously be of interest to the experimentally oriented radiotherapist, in view of the well known relation between mitotic activity and radiation effect. Radiation studies can contribute to our understanding of the mitotic cycle and its regulation, and yield fundamental insights into the mechanisms of mitotic inhibition, chromosome breakage, and subsequent cell death (5, 13, 31, 44, 49). As a biochemical counterpart to this approach, the radiologist must en-

deavor to learn more about the nucleic acids (7) and to assimilate recent information regarding their structure, their response to radiation (25, 36), the enzyme systems and physiologic factors concerned in their metabolism, and their presumed or established functions in the cell economy.

Recent dramatic contributions to the tissue-culture method by Eagle (10), Puck (37), and others (11, 16, 46) make it possible to grow human and other mammalian cells as single cell clones, or as suspensions, in partially defined media. These advances now permit the radiobiologist to explore the effects of nutrition and other factors on radioresponsiveness of homogeneous cell populations of different types and to study with some precision the nature of radiation-induced genetic injury in such cells.

Studies of the relative biological efficiency (RBE) of roentgen and gamma rays, electrons, alpha rays, neutrons, and other radiations, tested against a broad spectrum of simple biological systems (27, 41, 48), may also contribute to our understanding of the comparative importance of various primary radiochemical reactions in biological damage.

A number of pharmacological agents, such as cysteine (35), glutathione (6), cyanide (2), and mercaptoethylamine (3), significantly reduce lethality when given to animals just prior to systemic irradiation. These agents seem to exert their effects by decreasing the concentration of free oxygen in the cell at the moment of irradiation.

That oxygen concentration is important at the level of clinical radiotherapy was implicitly suggested as early as 1909, when Schwarz found that the cutaneous erythema reaction could be diminished by compression of its blood supply. Yet, little practical use was made of this knowledge, and it remained for Gray and his colleagues (17) to revive our interest in the subject within the last few years. They pointed out that response to radiation, not only in free-living microorganisms, but in several experimental solid tumors of mice as well, exhibited a distinct dependence on oxygen concentration (18). More important, they reasoned that, since many tumors tend to outgrow their blood supply and to develop foci of anoxia and necrosis, therapeutic failure might result from the survival of nests of anoxic, radioresistant cells in otherwise lethally irradiated tumors. This postulate was strengthened by careful histologic studies of several human tumors by Thomlinson and Gray (42). Finally, the experiment has been carried to its logical conclusion: Hultborn and Forssberg in Sweden have irradiated patients who were breathing an atmosphere of oxygen, with some encouraging results (21), and Churchill-Davidson and his colleagues at St. Thomas's Hospital in London (8) have placed patients with advanced cancers in a pressure chamber where they were subjected to three atmospheres of oxygen. Their preliminary results are shortly to be published. Although the practical difficulties attending their procedure seem likely to negate at least part of the anticipated benefits, we may all admire this courageous extension of a laboratory principle to the alleviation of otherwise hopeless human cancers.

Much remains to be learned about the radioresponsiveness of tumor and normal tissues in various animal species, and of human tumors grown heterologously in lower animals, either in solid form or adapted as ascites tumors. Encouraging studies by Lorenz and his associates (19, 20) in the past few years, pointing to the possibility of significant modifications of tumor behavior after combined total-body and local irradiation, require further systematic exploration. Recently, other efforts to exploit the protective effect of bone marrow in the treatment of mouse leukemia with LD 100 doses of systemic irradiation have been reported by Barnes and associates (4) and by Trentin (43).

Despite the fact that dose fractionation has been used clinically since its introduction by Coutard thirty-five years ago, there are still no experimental data to support our current practice of using essen-

tially the same treatment schedule for all tumors, and some evidence exists to the contrary (38). It would be highly desirable for radiotherapists to initiate studies on a variety of human neoplasms, grown in heterologous hosts or in tissue culture, to determine whether each has a mitotic cycle and post-irradiation recovery rate sufficiently characteristic to dictate the use of different fractionation schemes for different tumors, as has been advocated on cytological grounds (14, 28).

The important role of the tumor bed (9, 15, 45) is still poorly understood; in the past several years, observations have been made on the response of the capillary endothelium to irradiation, and on the effect of this response on tumor viability (30, 32, 33). We need much more information about the vascular, connective tissue (22), phagocytic, and humoral components of the host's defense apparatus against cancer.

Finally, the possibility that combinations of selected chemotherapeutic agents and irradiation might act synergistically in the control of cancer deserves vigorous experimental study (34, 39, 47). Using such combined therapy, Shapiro and Kligerman (40) have recently obtained results which, while preliminary and limited thus far to a single experimental tumor, are nonetheless of interest, though they must be viewed with caution in the light of failure to confirm a previous instance of apparent synergism (26).

At a more clinical level, we most urgently need to devise new technics for more precise delineation of the extent of tumor spread, and for discovering the existence and localization of metastases. In this connection, it is interesting that local irradiation (12, 23, 24), cortisone (1), and other factors have been shown to influence the capacity of specific experimental tumors to metastasize; additional studies of this type may help us to understand and possibly even to control and prevent metastasis. Methods for the early diagnosis of cancer at many major sites on a population-wide basis are also sorely needed and, by uncovering a larger proportion of early cases, would contribute much to the efficiency of radiotherapy.

It may be that when answers to all of these questions have finally been obtained, it will still not be possible for us to modify tumor response selectively, and thus to effect major improvements in present cure rates. It is only through biological research, however, that we can hope for a real breakthrough. By a concerted effort to reorient both our training and our research in this direction, we may be able to create a new generation of radiotherapists trained to apply experimental methods to the revitalization of their chosen field. It is not too late.

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SUMMARIO IN INTERLINGUA

**Recercas De Radiation E Le Futuro Del Radiotherapia**

Es interprendite un evalutation del stato presente e del potentialitates del recerca in le campo del radiotherapia clinic. Es considerate certe problemas que resulta del practica currente in America de unir radiodiagnose e radiotherapia in le manos de un sol practicante. Un effecto de iste practica es le necessitate de un programma hybrida de training pro residentes, con inadequate amontas de tempore dedicate al therapia. In plus, le diagnostico-therapeuta non vide un satis grande numero de casos a tractar contra cancere pro mantener un interesse vital in iste parte de su specialitate, e le casos de iste genere que *es* presentate a ille representa un reduction correspondente del material manipulate per le grande centros de radiotherapia. Per consequente, mesmo iste centros non dispone de un sufficientemente grande volumine de casos de cancere de forma curabile representante le mesme typo specific pro poter effectuar studios de validitate statistic.

Le autor se concentra principalmente super le radiobiologia. Cancere es un problema biologic; su destruction per radiation es un responsa biologic, e le morbo e su tractamento pote esser comprendite solmente super le base de conceptos biologic. Le conclusion es que facilitates e tempore pro investigationes laboratorial de radiobiologia deberea esser providite pro residentes qui se specialisa in radiologia. Lecturas, discussiones, e seminarios concernite con themas radiobiologic deberea esser incorporate in le programma de training, e cursos in iste disciplinas deberea esser offerite a congressos national. Finalmente le Consilio de Radiologia (i.e. le "Board of Radiology") deberea introducer questiones relative el conceptos fundamental de radiobiologia in su examines therapeutic e per le appunctamento de specialmente qualificate examinatores in iste campo.

Es enumerate certes del problemas que demanda recercas radiobiologic.

# Fractures of the Distal Radius and Ulna and Dislocation of the Proximal Carpals[1]

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THE WRIST is commonly injured in falls on the outstretched hand, the character of the injury depending to a considerable extent upon the brittleness of the bones and the relative strength of the muscles and tendons upon which the forces of stress are exerted. In general, such falls tend to produce fractures of the radius and ulna in children and also in weak or elderly individuals. The same stresses in strong adults are prone to result in carpal dislocation or fracture of the scaphoid. The inherent toughness and elasticity of juvenile bones favor greenstick fracture. The brittle cortex and trabecular fragility of senile bones predispose to comminution, impaction, and T-fractures. There are endless varieties of fractures of the wrist, most of which are too well known to radiologists to justify extensive discussion here. A few are exemplified in Figure 1. We prefer descriptive adjectives to proper names in the identification of fractures.

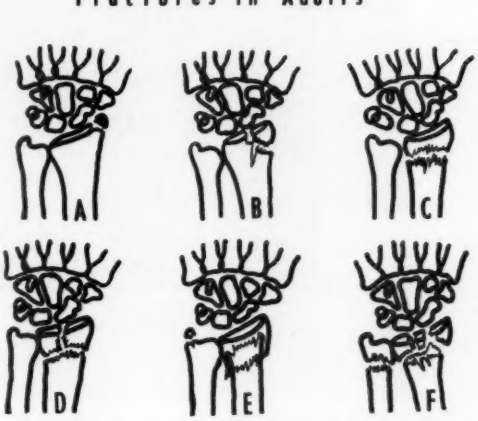


Fig. 1. Line drawing illustrating some common fractures in adults. A. Chip of radial styloid. B. Oblique fracture of radial styloid extending into joint. C. Transverse fracture of distal radius. D. T-fracture of distal radius. E. Transverse impacted fracture with avulsion of ulnar styloid. F. Comminuted fracture of distal radius with transverse fracture of distal ulna.

## EXAMINATION

The importance of adequate clinical and radiological study cannot be overemphasized. Multiple views, special views, and fine-detail technics are imperative. The use of a good magnifying lens is recommended. Films of the contralateral wrist are frequently helpful, particularly in children when the secondary centers of ossification may present problems.

The radiologist should examine clinically all patients referred for radiological study. Frequently, a few well chosen questions will resolve diagnostic difficulties. We prefer to question and examine the patient after having seen the "wet films." This is also an advantageous time for ordering special views, improving technics, and securing films of the contralateral wrist if indicated.

## LIMITATIONS

*Unrecognized Fractures:* In spite of all the above precautionary measures, one may fail to demonstrate an abnormality which is clinically suspected. In such cases it is wise to treat the wrist as though it were fractured and to re-examine it in a week or ten days. This applies not only to scaphoid injuries (which are outside my province) but also to injuries of the bones and epiphyses of the forearm. Figure 2 illustrates such a "missed" fracture which was clearly demonstrated fourteen days later.

*Misdiagnosis of Fracture:* Occasionally, sesamoid-like accessory ossicles are found

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Fig. 2. Undemonstrated fracture. A. Original roentgenogram, with no fracture demonstrated in the distal ulna. B. Film obtained fourteen days later, showing callus, new bone, and fracture lines.

in the wrist, and one is faced with the problem of differentiation between accessory bone and fracture. More than twenty carpal accessories have been described (6, 7). Although they may be mistaken for chip or avulsion fractures, careful attention to contour and reference to a chart such as is shown in Figure 3 should be helpful. The bilateral accessory pisiform bones of the nine-year-old child shown in Figure 4 has might simulate fractures of the ulnar styloids. Double ulnar styloid centers have been described (1) but are not readily confused with fractures.

Double ossification centers occur infrequently in the wrist. These may lead to the production of bipartite carpal bones simulating fractures (10). Although some "double" bones are unquestionably congenital, most of the double scaphoids probably result from unrecognized fractures. In some cases it is impossible to differentiate between these two conditions.

On the other hand, old ununited fragments from the ulnar styloid may simulate congenitally separate ossicles. Fragments avulsed from the ulnar styloid frequently remain ununited, and in children these often grow to become smoothly rounded, resembling accessory centers of ossification, as shown in Figure 5. Most of these can be considered to be the result of old fractures if they are unilateral and if there is flattening or sclerosis of the opposing surfaces. The history may be helpful.

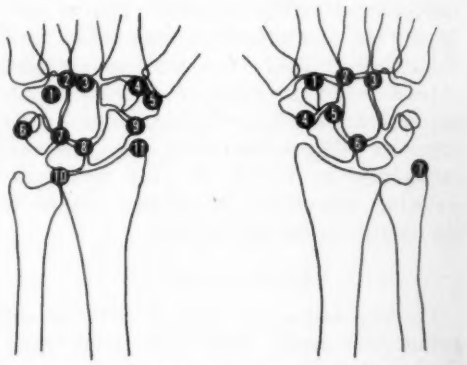


Fig. 3. Accessory carpal bones (terminology from O'Rahilly, 6).

*Palmar aspect*
1. Os hamulare
2. Os gruberi
3. Os subcapitate
4. Os praetrapezium
5. Os paratrapezium
6. Os pisiforme secundarium
7. Os hypotriquetrum
8. Os hypolunate
9. Os radiale externum
10. Os triangulare
11. Os radiostyloideum

*Dorsal aspect*
1. Os trapezoideum secund
2. Os metastyloideum
3. Os capitate secund
4. Os epitrapezium
5. Os centrale
6. Os epilunate
7. Os ulnostyloideum

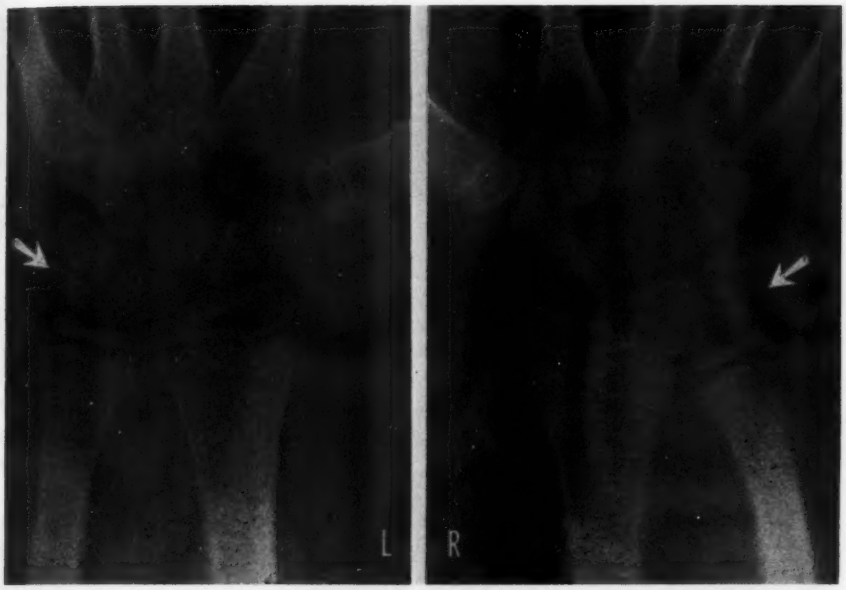


Fig. 4. Postero-anterior film of both wrists of a nine-year-old asymptomatic child examined for determination of bone age. Rounded accessory ossification centers are present just distal to and mesial to the partially ossified ulnar styloids. These are on the palmar surfaces and represent accessory pisiforms.

Fig. 5. Separate large smooth ossicle in position of ulnar styloid in an adult. This is believed to represent an unhealed fracture.

## DISLOCATIONS OF THE PROXIMAL CARPUS

Any of the carpal bones may become dislocated with or without fracture (2, 3, 5). Recurrent dislocation of the scaphoid has been described (8, 9). Because they are so frequently overlooked, however, we shall discuss briefly dislocations of the lunate and its immediate neighbors. One must observe the lunate and determine its relationships to the capitate and the radius in every wrist which has been subjected to trauma. Failure to do this may result in an error and cause marked patient disability. The relationship of the head of the capitate to the notch of the lunate and of the lunate to the radius is best evaluated in the lateral view. Any

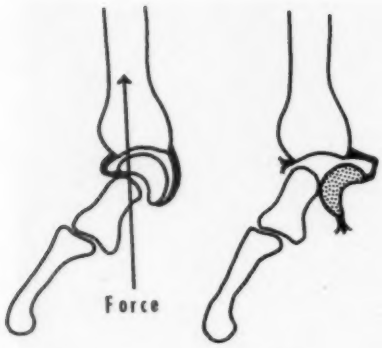


Fig. 6. Probable mechanism of dislocation of the lunate (modified from Watson-Jones, 9). In the view at the right there has been extrusion of the lunate and avulsion of the dorsal ligaments The head of the capitate approaches the articular surface of the radius.

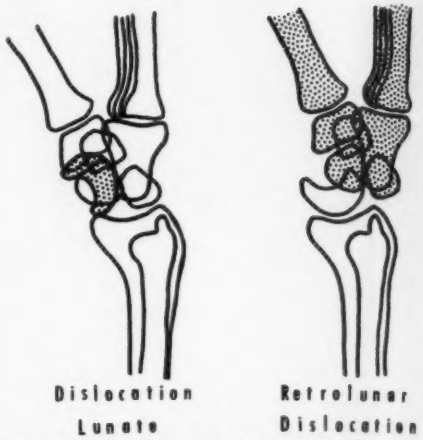


Fig. 8. Wrist dislocations in lateral projection. The dislocated bones are stippled.


Fig. 7. Lateral views of the wrist. A. Retrolunar dislocation of the carpus. B. Comparable view of normal wrist. The cup of the lunate receives the head of the capitate.

deviation from normal is a reliable indication of dislocation which is of two general types:

*1. Isolated Dislocation of the Lunate:* In this variety, direction of force causes the lunate to rotate so that its notch faces the palm and does not receive the head of the capitate. The lunate is, of course, displaced slightly toward the palm, while the capitate slides dorsally. This dislocation is contingent upon avulsion of the dorsal radiocarpal ligament. The mechanism is shown in Figure 6.

*2. Retrolunar Dislocation of the Carpus:* In this instance, the lunate remains in position with respect to the radius but the capitate is displaced out of the lunate notch and toward the dorsum of the wrist, carrying all the other carpals with it. It is remarkable how frequently this abnormality is overlooked because of failure to study carefully the relationships


Fig. 9. Fracture-epiphyseal displacement of the distal radius. The radial epiphysis and numerous slender fragments of the metaphysis are displaced toward the extensor surface.


Fig. 10. Films of the wrist of a child who fell on the outstretched hand. A small metaphyseal fracture is seen extending into the epiphyseal cartilage in A. The lateral view (B) demonstrates slight tilting and displacement of the epiphysis. Crushing injury to the growing cartilage can be evaluated only by means of long-term follow-up studies.

in the lateral view. The classical features are shown in Figure 7.

Fracture of the scaphoid or other carpal bone may complicate the dislocation and, unless care is exercised, the fracture may distract attention from the dislocation. Figure 8 shows diagrammatically the two principal types of proximal carpal dislocations.

### EPIPHYSEAL INJURIES

Epiphyseal separations with displacement are essentially fractures through the distal metaphysis (9). Even when the roentgen appearance suggests fracture through the cartilage, the line of cleavage is on the metaphyseal side of the epiphyseal plate and fragments of trabeculae are displaced along with the epiphysis. An example is shown in Figure 9. Fortunately, in such injuries restitution of alignment is readily accomplished. Since vascularity is excellent and the cartilage columns are not seriously disturbed, there is seldom any deformity or inhibition of growth.

A more serious injury to the growing cartilage may result from a fall on the dorsiflexed wrist without gross displacement or recognizable fracture. This injury consists of crushing of the epiphyseal cartilage. The roentgen manifestations may be minimal or absent but follow-up studies over a period of years often disclose premature fusion. Figure 10 illustrates minimal abnormalities which should not be overlooked in this type of injury. Crushing injuries to the cartilage in the wrist usually involve only the radius. The ulna continues to grow, resulting in radioulnar dislocation and deviation of the hand, which may require operative correction. Patients with epiphyseal crush injuries must be studied with care and followed for several years.

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### SUMMARIO IN INTERLINGUA

#### Fracturas De Radius E Ulna Distal E Dislocation De Carpales Proximal

Es sublineate le importantia de adequate studios clinic e radiologic in le presentia de vulnerationes del carpo. Il occurre que fracturas non appare in le roentgenogrammas original sed deveni demonstrabile post le passage de plure dies. A parte isto, ossiculos accessori pote esser misprendite pro fracturas o vice versa. Nulle del ossos carpal es exempte de dislocation, con o sin fractura. Attention special es invitate al dislocation isolate del osso lunate e a dislocation retrolunar del carpo.

Separationes epiphysee es in realitate fracturas de metaphyse distal. Mesmo quando le conformation roentgenographic suggere le presentia de un fractura a transverso le cartilagine, le linea del fission es al latere metaphysee del platta epiphysee, e fragmentos de trabeculas es displaciate insimul con le epiphyse. Felicemente, restitution del alineage es facile a effectuar, e deformitate occurre infrequentemente. Vulneres contusional del cartilagine epiphysee es plus serie.

# Posterior Dislocation of the Shoulder[1]

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THE SHOULDER is the most frequently dislocated joint in the body (6). Ninety-five per cent of all its dislocations are anterior. Certain rare dislocations—superior, inferior, and intrathoracic (9)—and posterior dislocations account for the remainder. The latter constitute approximately 2 per cent of the total. The lowest incidence reported is just under 1 per cent, in a series reviewed by Ellerbrolk and cited by Dardel (Thomas, 11). Ellerbrolk is said to have seen only 4 instances in 404 cases of shoulder dislocation. The highest incidence, 3.78 per cent, is reported by McLaughlin (7), who saw a total of 22 cases in a series of 581 dislocations involving the shoulder joint. Wilson and McKeever (14) found 4 examples in 260 cases of shoulder dislocation. In fifteen years at Massachusetts General Hospital (15), there were 5 instances in 200 shoulder dislocations, an incidence of 2.5 per cent, or about one case every three years.

Posterior shoulder dislocation thus accounts for such a small percentage in most series that it automatically recedes into the background as a possibility (9, 13) and is therefore often overlooked, with dire consequences, as will be demonstrated in the cases to be presented. This point is stressed almost unanimously in the literature, especially in pathological descriptions of chronic or recurrent dislocation (4, 9, 13).

Bilateral posterior dislocation has been reported by Coover (3), McLaughlin, Wilson and McKeever, and Thomas (quoting Mynter). A bilateral dislocation reported by McLaughlin had gone undiagnosed for thirty-five years.

Less severe degrees of posterior dislocation—so-called subacromial dislocation (11)—may be missed either when they are associated with other severe bodily injuries, coma, shock, etc., or with a fracture of the upper humerus. This lesser degree of displacement is the subject of an unusually thorough review by Thomas. When such dislocation occurs alone, it is extremely difficult to demonstrate even with stereoscopic films, as noted in the literature (8, 11, 14, 15).

Posterior dislocations are the result of forces the opposite of those producing anterior dislocation. There is usually a history of internal rotation and adduction, as noted in all series and most isolated case reports, and the clinical deformity is of that type. At times there is complete loss of ability to abduct the arm (8). This is not invariably the case, however, and some patients with posterior dislocation can abduct the arm well enough to allay suspicion as well as permit easy examination of the shoulder by means of a view axially directed with reference to the trunk of the body. This view, called the lateral view by some reporters, may be unobtainable (8). Where conditions permit, it is invaluable.

Posterior dislocations of the shoulder are often associated with convulsive seizures, especially those of epilepsy and electric shock, both accidental and therapeutic (7, 9, 10, 11). They may occasionally occur in certain diseases of musculature and in the presence of softening and laxness of the joint capsule (9), as well as following direct backward trauma.

The infrequency of posterior dislocations is apparent from all series reviewed (7, 9, 10, 14, 15) and is emphasized by the fact that the 7 cases presented here were col-

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[1] Presented as part of a Panel Discussion on Fractures, at the Forty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1956.

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lected from two large teaching institutions and two private offices. The case with immediate diagnosis and reduction without apparent sequelae (Case VII) was brought to our attention after the Symposium on Trauma at the 1956 Meeting of the Radiological Society of North America, through the kindness of another member of that panel. This case came from a hospital where especially meticulous care is used in the examination of the shoulder joint.

It seems likely that permanent changes due to vascular injury and pressure necrosis begin quite promptly. The case with reduction four days following injury (Case VI) presented a bone defect at a later date. It is presumed that the patient with immediate closed reduction had no sequelae, since she returned for a one-month check-up without complaint or disability and later disappeared from sight. The problem of late sequelae following early reduction lies outside the scope of this paper.

Probably the most important factor in recognizing a subacromial posterior shoulder dislocation is a knowledge of the anatomy and the relationships of parts in this region, coupled with a firm conception of the normal radiologic appearance in various projections (1, 2, 5, 12). The development of a high index of suspicion in injuries of the shoulder joint is probably the next most important factor in prompt diagnosis.

There is another approach to the elimination of error. This is by modification of the method of projection, as suggested by the following adages. The first of these is: Never be satisfied with one view. The next might be: Secure views at right angles, which could be difficult (8). Another would be: Use projections made at several different angles. The last is the simplest: Obtain similarly projected views of both sides for direct comparison.

There are undoubtedly occasions when various diagnostic maneuvers will be successful in the detection of subacromial posterior dislocations, but which of these maneuvers should be attempted in a given case it is impossible to state with certainty without knowing the status of the patient requiring examination and where the examination is to be done. A variant of the usually accepted maneuvers, as suggested by the adages given above, is likely to succeed in most patients even if comatose or suffering from other severe injuries which prevent manipulation and positioning.

This variant consists in obtaining simultaneously projected views of both shoulder joints with a decreased tube-to-film distance. This is accomplished by placing a 14 × 17-inch film transversely behind the patient and projecting both shoulders at the same time by means of rays divergent from the central ray of the tube, which enters the midline of the body in the region of the top of the sternum. This can be done with Bucky technic or grid cassette. If the shoulders are too broad to permit demonstration when the tube distance is shortened to 26 or 30 inches, or if the equipment is not adequate, approximately the same result can be obtained by centering the tube over the midline and angling the central ray laterally to such a degree as to project the shoulder joint upon a film properly placed behind the joint and lateral to it. This will permit projection of the joint and exaggerate posterior displacement, if present. It is followed by a similar projection of the opposite shoulder. It is essential that both arms, forearms, and hands be in exactly the same position during any projection of both shoulders for the purpose of comparison. *Any* dissimilarity should arouse suspicion and indicates the need for further studies.

A film thus providing a comparative and slightly exaggerated view of both shoulder joints in similar position, simultaneously or similarly projected, may well prove to be of value in many instances of trauma when there is need for a comparison. It could be useful in comatose or obese patients and in other conditions presenting diagnostic difficulties.

The case abstracts and illustrations which follow have been arranged in an attempt to show the serious end-results of missed diagnosis, the typical defect or

notch, the appearance in axial projection, atypical defects, the result in slightly delayed reduction and, finally, immediate diagnosis with prompt reduction. The transthoracic lateral view is not included

Fig. 1. Case II. End-result of undiagnosed dislocation eventually resulting in autofusion.

because it is often hard, if not impossible, to obtain, its interpretation is difficult, and at a later date bone detail is extremely poor due to necrosis and atrophy. In fact, detail is so unsatisfactory that an adequate reproduction cannot be obtained.

## CASE ABSTRACTS

CASE I. Male. While sitting in an automobile, the patient had a *convulsive seizure* followed by unconsciousness lasting about one hour. On admission, fracture of the surgical neck of the humerus with posterior dislocation of the head and fracture of one leg were diagnosed. Effort at reduction of dislocation by means of manipulation was unsuccessful. (Dr. Dennis)

CASE II (Fig. 1). Male, mechanic. This patient was said to have sustained a direct blow to the anterior shoulder by a garage door. He had been seen by a general practitioner and x-ray examination had been reported negative. A roentgenologist also reported negative findings. Subsequently the patient was seen by two orthopedists, and a third orthopedist reviewed the films. Their verbal report was "sicklemia." The diagnosis was then made by a radiologist. The same orthopedic consultants hospitalized the patient and concurred in the diagnosis. They agreed that adequate autofusion had taken place. The patient received compensation for two-thirds total loss of use of the right arm.

Fig. 2. Case III. Posterior dislocation essentially untreated because of cardiac complication. Appearance at three weeks, with typical anterior groove or notch.

Fig. 3. Case III. End-result at five years. Closed reduction was done after three months.

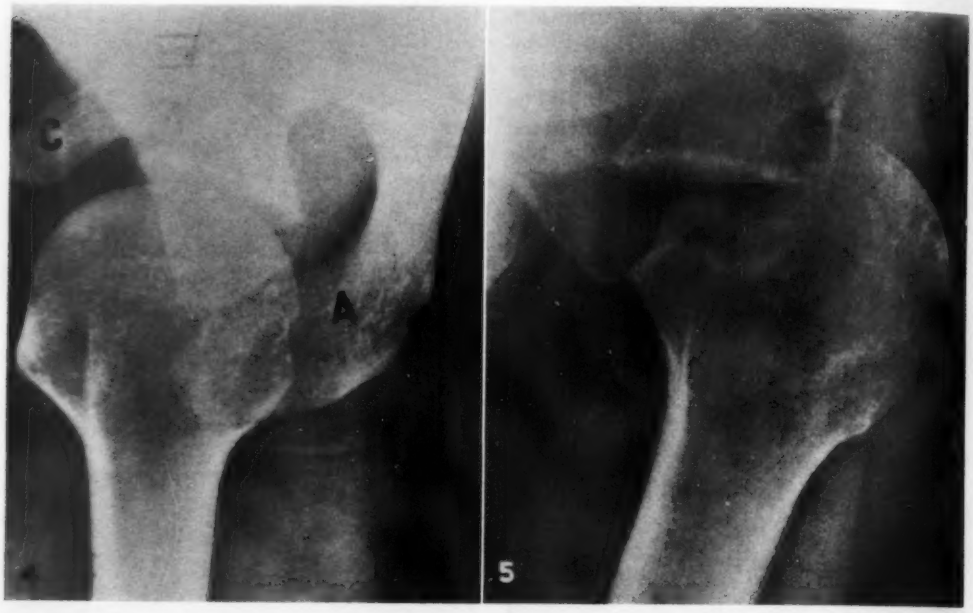


Fig. 4. Normal axial view (supero-inferior or vice versa), for comparison with Fig. 5. A. Acromion. C. Coracoid. This view is difficult to obtain unless the arm can be abducted.
Fig. 5. Case IV. Axial view (supero-inferior or vice versa), showing dislocation and defect; also erosion of neck of scapula posteriorly.

Fig. 6. Case IV. Similar simultaneous projection of both shoulders to confirm diagnosis made from single anteroposterior film.

There was *no known history of epilepsy.* (Dr. Davidson)

CASE III (Figs. 2 and 3): Male. The patient, a *known epileptic,* had a coronary occlusion and mild cardiac infarction. He was treated primarily for the cardiac infarction, since this was considered of greater importance than the complaint of pain in the right shoulder. He also received treatment intended for bursitis. The diagnosis of posterior dislocation was made with great difficulty three weeks following admission. No treatment was instituted because of the cardiac condition. *Three months after injury,* there was marked deformity of the humeral head as well as atrophy of all the bony structures. A *closed reduction* was carried out. A follow-up film five years later showed multiple loose bodies simulating osteochondromatosis. It could also be misinterpreted as showing a neurologic joint. (Dr. Dennis)

CASE IV (Figs. 5–8): Male. While carrying out electrical repairs on a wet tile floor, the patient received a *severe electrical shock.* Upon admission, dislocation was suspected, but was not apparent on standard films. Subsequent films were interpreted as showing, among other things, necrosis following electrical shock and tuberculosis. Three months following injury, roentgenograms made elsewhere were interpreted properly, but the diagnosis was not accepted and not confirmed until six months after the original injury. At that time an exploratory operation was carried out, dislocation was confirmed, and the shoulder was fused. Bacteriologic and microscopic studies at the time of operation were negative. (Dr. Brown)

CASE V (Figs. 9 and 10). Male. The patient, a *known epileptic,* gave a history of many severe seizures, during at least one of which he had suffered an anterior dislocation of the shoulder. He was admitted for neurologic evaluation and possible sur-

gery. Films of the shoulder were obtained, and a diagnosis of posterior dislocation was made by a senior radiologist. Special views for confirmation were requested and obtained after considerable difficulty. These established the presence of posterior dislocation, with a typical anterior groove. A posterior groove, obviously from previous anterior dislocation, was also demonstrated. This diagnosis and the presence of an unstable humeral head was made by the resident. Because of the severe epilepsy and marked deformity of the head, recurrence of the dislocation if it were reduced, or fracture of the humerus if fusion was done, seemed likely. Accordingly, the humeral head was removed. This was originally consigned to the bone bank, but bacteriologic studies proved positive and the specimen was recovered for photography and radiography by the resident. (Drs. Rubin and Brown)


Figs. 7 and 8. Case IV. Normal (right) shoulder and abnormal (left) shoulder, showing exaggeration of displacement, made from film shown in Fig. 6.

CASE VI (Fig. 11). Female. The patient *blacked out* for an undetermined period while carrying pails of milk from the barn to the house. She entered the hospital complaining of pain in the shoulder and admitted *previous* "*fainting*" episodes. It is probable that she had epilepsy. At the time of admission there were fractures of the fifth and sixth thoracic vertebrae in addition to a posterior dislocation of the shoulder. Closed reduction was done four days

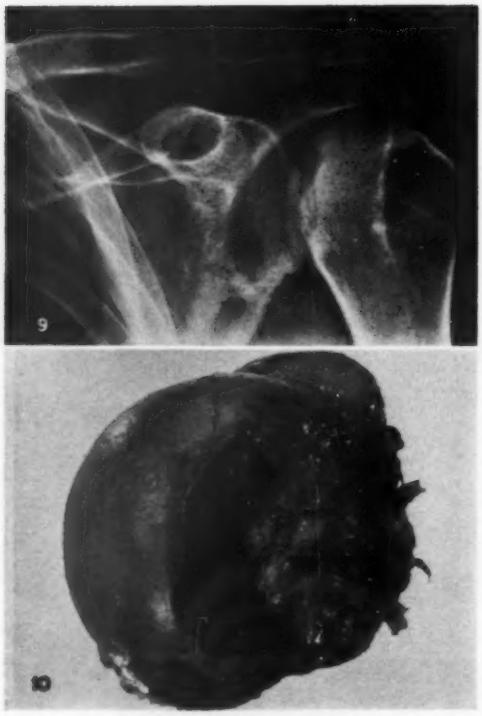

Fig. 9. Case V. Anteroposterior view showing both anterior and posterior grooves with abnormal relationships; confirmed and accentuated in similar simultaneous projection.

Fig. 10. Case V. Photograph of humeral head after removal, showing both anterior groove resulting from posterior dislocation and posterior groove resulting from previous anterior dislocation. Incidental operative fracture.

after admission. Following immobilization, there was beginning return of motion in the shoulder joint one month after the original injury. A follow-up film showed a bone defect with loose body. (Dr. Dennis)

CASE VII (Fig. 12). Female. Examination was made in the evening as an emergency Dislocation was not apparent on stereoscopic films but was definitely suggested in the anteroposterior view with the patient sitting erect against a Bucky diaphragm with the unaffected shoulder rotated 15° away from the Bucky in an attempt to "open" the affected joint space. Dislocation was reduced the following day (less than twenty-four hours), with considerable difficulty, by the orthopedic surgeon, who was not certain of reduction. The patient, however, was sure. At the end of one month she had no complaints and motion was adequate. She returned to work and subsequently was lost to follow-up. (Dr. Fulton)

## DISCUSSION

Posterior dislocation of the shoulder is an infrequent injury and, because of this, is apparently often overlooked. Lesser degrees of posterior displacement, generally described as subacromial, are especially rare, probably accounting for around 1 per cent of all shoulder dislocations. Nerve and vascular complications are not often seen, since these structures lie anteriorly. Bone, capsule, and tendon injuries are relatively common. To these changes there are added marked atrophy, necrosis, and deformity in the later stages of chronic dislocation or recurrence.

Results are said to be excellent if reduction is accomplished promptly and can be maintained. Recurrence is common. Watson-Jones (13) states that over 80 operations on the shoulder joint have been described, suggesting the difficulties that may be encountered in this area, as well as the unsatisfactory results that may follow any type of dislocation.

Wilson and McKeever appear to have contributed the most significant approach to the problem of posterior dislocation in recent years. Once the dislocation is discovered, they advocate closed reduction and maintenance by means of cruciate wires transfixing the acromion and lateral margin of the head of the humerus for three weeks, to permit healing, the closure of a rent, reattachment of torn tissues, and obliteration of pouches. This seems to be essential if recurrence is to be avoided. Closed reduction may be possible as late as twelve weeks after injury. By this time degenerative changes are quite marked and maintenance of reduction may be impossible by ordinary means.

The need for early detection and prompt reduction is apparent. The procedures used in diagnosis are of importance. The following radiologic projections are all useful and may succeed in certain circumstances but no one projection is possible under all circumstances or is uniformly successful.

1. Anteroposterior.

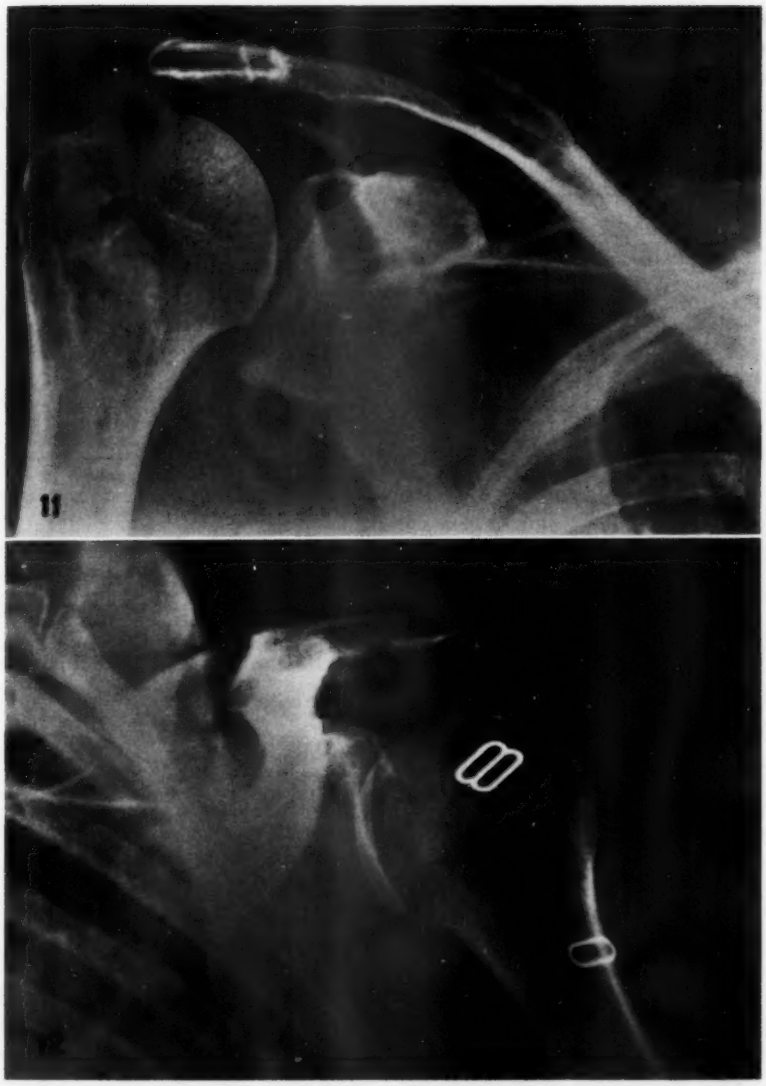

Fig. 11. Case VI. End-result of closed reduction four days following injury. Note residual bone defect.

Fig. 12. Case VII. Immediate diagnosis by means of single special oblique film with reduction on following day. No known residual change.

2. Anteroposterior stereoscopic, horizontal shift.
3. Anteroposterior stereoscopic, vertical shift.
4. Anteroposterior in internal and exterior rotation.
5. Transthoracic lateral (erect).
6. Axial (or lateral). Supero-inferior or inferosuperior, with arm abducted.
7. Axial view of the scapula with central ray tangential to ribs.
8. Semioblique, with the affected shoulder against the Bucky diaphragm and the unaffected shoulder rotated 15° or 20° away from the Bucky diaphragm.

9. Planigraphic studies. These may be of assistance but are not very practical universally or in emergency situations.

In addition to any other more standard views, it is suggested that one may use a simple projection which gives a comparison film of the two sides. This view exaggerates any abnormality of relationship. It can be obtained on comatose patients and even in bed. The only absolute requirement is that both shoulders be projected similarly, with both upper extremities in exactly the same position down to and including the hands. This view has proved useful in practice.

SUMMARY

1. Minor degrees of posterior dislocation of the shoulder are infrequent and often result in serious disability if not promptly detected and reduced.

2. Methods of demonstrating such injuries are noted.

3. A further approach to prompt and accurate diagnosis is suggested.

4. Typical cases and end-results are presented.

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SUMMARIO IN INTERLINGUA

**Dislocation Posterior Del Spatula**

Le occurrentia de dislocation posterior del spatula es rar. Isto es particularmente ver pro grados minus pronunciate de dislocation posterior, communmente cognoscite como subacromial. Le detection de iste vulneres e lor prompte reduction e bon mantenimento es importante pro le prevention de subsequente invaliditate. Le sequente vistas radiologic es recommendate como utile, ben que nullo in le serie es possibile sub omne conditiones o pote succeder in omne casos. Le vistas in question es: antero-posterior; antero-posterior stereoscopic, con displaciamento vertical e horizontal; anterio-posterior in rotation interne e rotation externe; trans-thoracic lateral; axial (supero-inferior o infero-superior) con abduction del bracio; vista axial del scapula con fasce central in direction tangential al costas; semi-oblique con le spatula afficite contra le diaphragma de Bucky e le non-afficite spatula rotate a 15 o 20 grados ab le diaphragma de Bucky; e vistas planigraphic.

A parte le vistas plus o minus standard, projectiones simultanee de ambe spatulas—a breve distantia inter tubo e pellicula e con le extremitates superior (incluse le manos) in exactemente le mesme position—es recommendate pro le comparation del duo lateres.

Casos illustrative es reportate.

# Whiplash Injuries of the Cervical Spine[1]

DOUGLAS B. NAGLE, M.D.

THE PURPOSE of this paper is to review some of the less obvious roentgenographic evidences of cervical spine injuries resulting from the so-called whiplash mechanism. This seems to be appropriate in view of the continuing increase in automobile traffic, the attendant rise in the number of accidents with resulting passenger injuries, and the frequency of insurance suits and claims. These factors have brought about a growing demand for diagnostic x-ray examinations in cases of trauma of all sorts. As a result of a true rise in the number of actual injuries resulting from accidents, and perhaps also of the increasing possibility of medicolegal complications from real or dubious injuries, it is almost routine for the emergency treatment centers of our hospitals to request x-ray examinations for trauma of even apparently minor degree. It cannot be denied that an overcautious attitude in ordering x-ray examinations "to rule out injury" is desirable preventive medicine, but this attitude has undoubtedly been indirectly responsible in some measure for the rise of insurance claims and litigation by overattention to the nonseriously injured (1). This situation is especially true of injuries of the spine, particularly of the cervical area.

The rather unique structure of the cervical spine, which is anatomically different from other sections of the vertebral column, renders this part of the body readily vulnerable to indirect injury from the sudden forces of acceleration and deceleration that are frequently encountered in traffic accidents. By definition, a true whiplash injury consists in a hyperflexion of the neck resulting from a violent forward thrust of the head when the motion of the body has been suddenly slowed or stopped, as in a head-on collision, or a recoil hyperflexion following hyperextension produced by acceleration of the body from behind. The relatively large weight of the human head which is supported on a narrow column of bone, coupled with the extreme mobility of the cervical spine, provide the potential energy of a whiplash force.

Cervical spine injuries are classified in general as bone injury (fracture), ligamentous injury (tear, avulsion, capsular rupture), and muscular injury (strain). Some of the injuries are obvious on clinical examination, as when there is associated spinal cord injury, with neurological sequelae. Some are obvious on the initial diagnostic x-ray study, as when a fracture or dislocation is readily apparent. These situations need not be considered further here. It is the patient who shows no gross clinical sign of injury or who, in spite of clinical suspicion, exhibits no x-ray evidence of injury on the initial study—which may be and often is of necessity limited—that needs more critical roentgenologic evaluation. The complete examination may ultimately require stereoscopic views and laminagrams in addition to the standard views.

The extent of the initial x-ray study is guided by the possible severity of the injury as evaluated clinically. A minimum study of the cervical spine includes single anteroposterior and anteroposterior transoral Bucky views plus a lateral view, made in the supine position, with a horizontal beam and grid-front cassette. These views can be obtained with minimal manipulation of the patient. If they show no clue as to the existence of an obvious injury, further examination may be undertaken. This may be done immediately or as a follow-up procedure.

Having excluded obvious injury, we

[1] Presented, as part of a Panel Discussion on Fractures, at the Forty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1956.

feel justified in proceeding with a more extensive study. For this, lateral projections are obtained, if possible with the patient erect, and with the neck in the neutral or straight position, as well as with the neck flexed and then extended to its fullest extent. Oblique views are desirable and may be the only ones that show fractures of the posterior arch, pedicles, or joint facets, or evidence of unilateral subluxation. Laminagrams are especially helpful in demonstrating fractures of the odontoid process or details of the atlanto-occipital and atlanto-axial joints. The presence of a fracture, dislocation or subluxation can usually be established by these means. The types of fractures most commonly encountered in whiplash injuries are those involving the lateral masses (2), posterior arches, transverse or spinous processes (3), of the vertebrae, or chip fractures of the anterior margins of the centra. Odontoid process fractures are not unusual. Fractures of the compression type, commonly met with in other parts of the spine, are of less frequent occurrence in the cervical area. It goes without saying that success in the demonstration of bone injury is related to good technic and adequate and proper views.

The ligamentous type of injury sustained following whiplash trauma is encountered just as frequently as a fracture, and its recognition is probably nearly as important. This problem is not as commonly appreciated as the fracture situation. For an understanding of the situation, one must recall the normal mechanics of the cervical spine and particularly the usual ranges of motion. Flexion and extension involve a gliding motion of each vertebral body upon the one beneath, as well as a rocking motion centered about a pivotal point located at the junction of the centrum and pedicles. The range of these movements is greatest in the midcervical spine, a fact that is reflected in the earlier appearance of degenerative arthritis in that area. Flexion and extension roentgenograms show these functions well (Fig. 1). Normally, with the neck in neutral position, the alignment is an uninterrupted curved line, convex anteriorly, in relation to the line of the posterior margins of the vertebral bodies. With flexion, a gliding motion of each vertebra forward and upward on

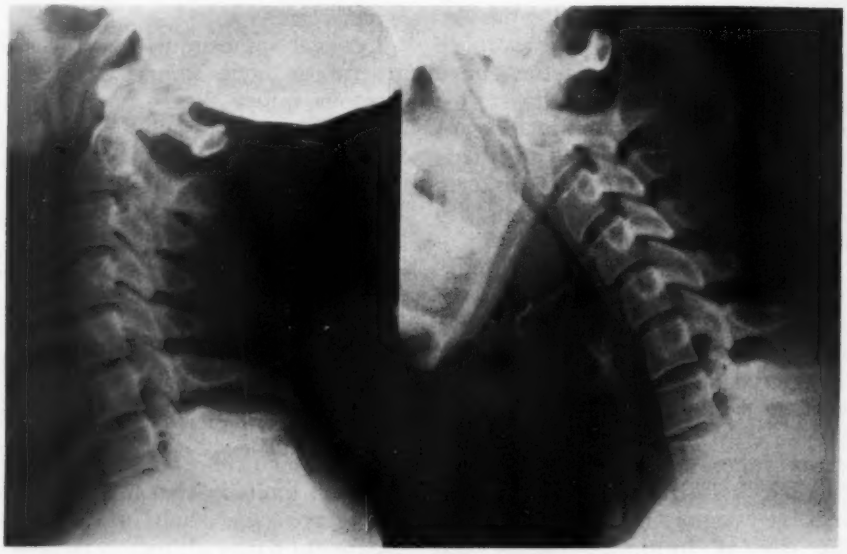

Fig. 1. Normal cervical spine motion. Note the gliding motion of the joints and the uniform curvature, with equal separation of the spinous processes posteriorly.

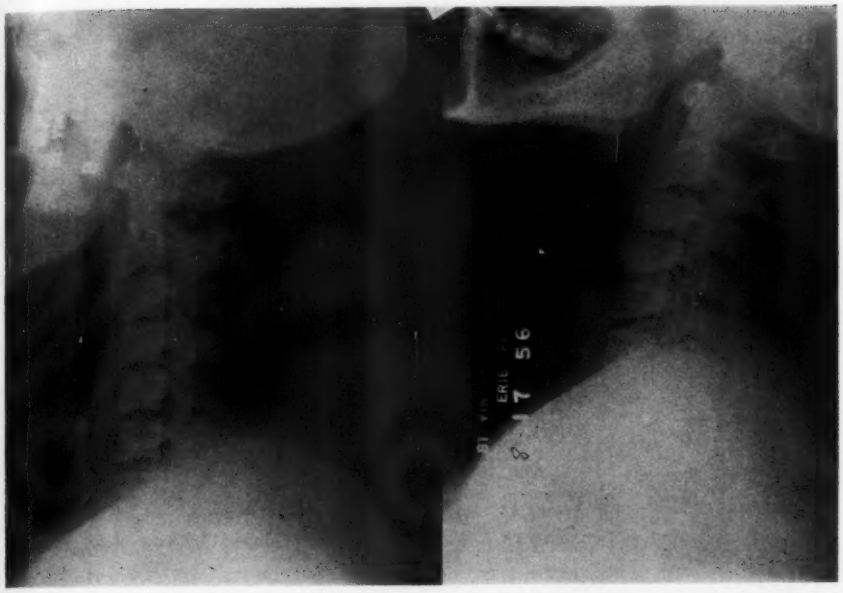

Fig. 2. Straightening of the normal lordotic curvature and relative fixation of motion produced by muscle spasm, *i.e.*, so-called "sprain" injury.

Fig. 3. Localized fixation of motion of the upper cervical spine (C-2 to C-4) with diminished joint motion and lack of normal separation of spinous processes. This implies some degree of focal ligamentous injury.

the subjacent one is noted, as well as some slight forward motion of the body and narrowing of the disk joint space anteriorly. There is also a uniform separation of the spinous processes posteriorly. The anterior curve may straighten and reverse, but the curved line remains uniform.

When injury from hyperflexion occurs,

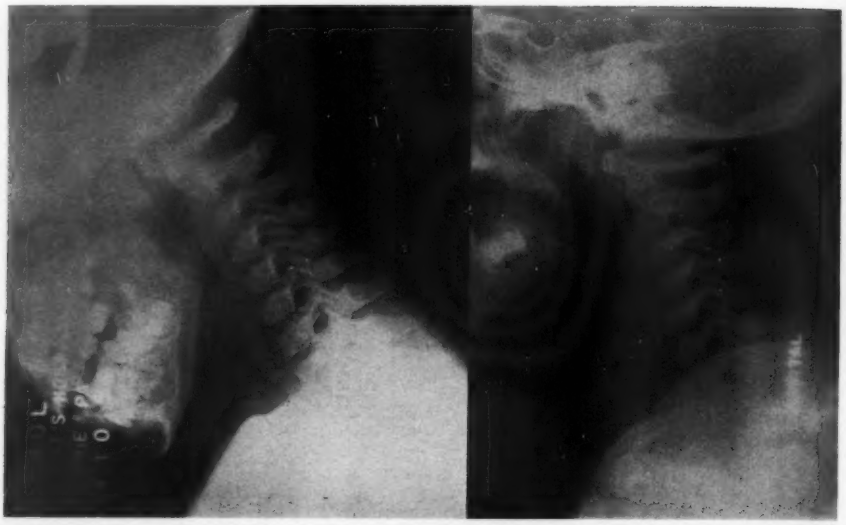

Fig. 4. Exaggerated motion between C-2 and C-3 in flexion, indicating tear of interspinous ligaments.

it begins as a tear of the capsular structures of the posterior joints, followed by rupture of the interspinous ligaments, and then tears of the fibers of the annulus fibrosus and actual disk injury (4). With greater stress, subluxation and/or fracture occur. The first stage of hyperflexion injury without ligamentous damage produces muscle strain, which will result in muscle spasm, with straightening or even reversal of the normal curvature and limitation of all motions (Fig. 2). There is, however, no focal disruption of the curve or of the alignment of the spine elements. With a lesser degree of ligamentous injury, wherein there is only partial avulsion of posterior joint capsular structures, the curve is also altered and there are localized reduction of the normal range of intervertebral motion and focal straightening of the curve (Fig. 3). It has been established experimentally that, if there is no disruption of the ligamentous structures, particularly the interspinous ligaments and annulus fibrosus, even great forces applied to flexion and extension will not alter the regularity of the curved line (5). In the presence of such ligamentous injury, however, the important clue again is a focal change of the smooth curve with angulation, as evidenced by increased range of forward gliding, exaggerated separation of the spinous processes, or widening of the facet joints posteriorly (Fig. 4). Interpretation must, of course, be varied to allow for degenerative changes. In patients with degenerative joint disease and resulting disk space narrowing and joint fixation, the curve will also be locally altered. In this event a decision must be reached as to whether the change is of long standing or due to recent injury. If there is no actual fracture or subluxation, this decision is not always possible.

The importance of recognizing cervical spine fractures is obvious, from the standpoint of proper treatment. We feel that it is equally important to recognize ligamentous injuries, since proper treatment, usually by an extension collar type of immobilization, of sufficient duration, will allow complete soft-tissue healing with a minimum of residual capsular or ligamentous stretching, which may give rise to subsequent symptoms.

*In summary*, whiplash injuries of the cervical spine are occurring with increasing frequency. In all such cases complete

x-ray examination is necessary to demonstrate bone or ligamentous injuries. Evidences of ligamentous injuries, when present, form a positive basis for definitive treatment.

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SUMMARIO IN INTERLINGUA

## Vulneres "A Colpo De Flagello" Del Spina Cervical

Le termino "whiplash injury" (i.e. vulnere a colpo de flagello) se usa in anglese como designation de omne vulnere resultante de inexpectate e violente excursiones del collo. Tal vulneres del spina cervical es vidite con frequentias crescente per le radiologo in tanto que accidentes de automobilismo accresce in frequentia, proque il ha un tendentia progressive de servir se de radio-examines pro excluder o establir le effectos de trauma.

Vulneres del spina cervical es classificate como ossee (i.e. fracturas), ligamentose (i.e. lacerationes, avulsiones, rupturas capsular), e muscular (i.e. diastrophias). Certes es clinicamente obvie, e alteres es clarmente apparente al roentgeno-examine initial. In altere casos ancora, plus extense investigationes es necessari, con vistas lateral e oblique a collo erecte, flexite, e extendite, e frequentemente con laminographia.

Vulneres ligamentose ha le mesme grados de importantia como fracturas. Quando presente, illos constitue un indication positive pro un tractamento definitive.

# Fractures of the Carpal Bones[1]

FREDERICK A. BAVENDAM, M.D.

THE EXPERIENCE of the average radiologist with fractures of the carpal bones is limited by the relative rarity of many of these injuries. The navicular fractures are most important and are relatively common. Other fractures are usually less significant, but the radiologist should be aware of their prognosis and the complications to be expected so that he may not only recognize the injury but, when requested, may advise the attending physician as to the significance of the individual injury and the advisability of management by an orthopedic surgeon.

The minimum examination of the wrist should include a postero-anterior view made with the hand in partial ulnar deviation, an oblique view with the hand in partial pronation, and a true lateral view. It is essential that the better detail afforded by a film exposed in a cardboard holder be obtained. Special non-screen film is desirable, since the exposure time may thus be significantly reduced. These films should be viewed wet as a basis for further study of the patient. The radiologist who does not combine a personal clinical examination with the roentgenographic studies will have a false sense of security and will fail to recognize many carpal injuries. Localized swelling and tenderness will indicate areas that need more complete evaluation. Pain upon percussion over the third metacarpal bone will indicate a fracture of the navicular bone. If the roentgenograms do not then clearly demonstrate a fracture, additional views should be obtained, such as a postero-anterior view with the hand in marked ulna deviation and an oblique view with angulation of the roentgen beam. Continued inability to completely extend the middle finger suggests a dislocation of the lunate. This clinical sign will be most helpful in evaluation of a persistent dislocation when the hand and wrist are in a heavy cast and roentgen examination may be difficult.

Local areas of tenderness of the volar surface will suggest the need of an axial or profile view of the anterior carpal bones. Fractures of the ridge of the greater multangular bone or the unciform process of the hamate bone may be recognizable only on roentgenograms made in this projection.

With a complete examination with non-screen film, the incidence of undiagnosed fractures should be negligible. If, however, pain persists unduly following an apparent sprain, re-examination is essential. Very rarely an avascular necrosis, such as Kienböck's disease of the lunate bone, will appear after an injury with no evidence of a fracture.

Unfortunately, some fractures of the carpal bones will be masked by associated injuries. A fracture of the navicular bone may not be recognized in a patient who has a Colles' fracture with marked deformity. Under such circumstances, a complete examination of the carpal bones is not practical, but the navicular fracture will usually be recognized if a careful evaluation of the carpal bones is made in all fractures of the wrist.

To be differentiated from fractures are supernumerary bones of the wrist. Diagrams indicating the locations of such accessory bones are commonly available in textbooks of radiology. Bipartite bones also occur but should not be confused with a recent fracture. A calcified bursitis can be recognized both by appearance and by the history of acute pain occurring without any significant trauma.

Multiple fractures are seen following gunshot wounds and severe industrial accidents such as may occur with power-

[1] Presented as part of a Panel Discussion on Fractures, at the Forty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2-7, 1956.

cutting tools or power presses. There is often loss of bone as well as soft-tissue injury, and disability is usually marked.

Isolated fractures of the individual carpal bones or less extensive multiple fractures are usually the result of falls upon the hand. A dislocation of the lunate bone or a Colles' fracture may be an associated injury. Ultimate function will usually be good unless avascular necrosis, nonunion, or a post-traumatic arthritis occurs.

*Os Naviculare:* Fractures of the navicular bone are the most common fractures of the carpal bones, and are particularly important because of the danger of permanent disability resulting from nonunion or avascular necrosis. The incidence of these complications is markedly increased if the fracture is not recognized early.

Fractures of the navicular bone should be classified as fractures of the tubercle, of the distal third, of the waist, and of the proximal third. Following conservative treatment, fractures of the tubercle all unite, with no apparent disability. Those of the distal third usually unite, with excellent function. The blood supply of the navicular bone is primarily through vessels in the region of the tubercle and the waist of the bone. An avascular proximal fragment occurs in 13 per cent of fractures of the middle third and in a much higher proportion if the fracture is situated more proximally in the bone. However, bony union and good function can result with an avascular fragment. Displacement with incomplete reduction is also a large factor in the occurrence of nonunion. Displaced fractures of the proximal third of the bone have a poor chance of union. Immediate excision of a small proximal fragment is often the treatment of choice.

*Os Lunatum:* Fractures of the lunate bone are rare. A severe injury may produce general comminution of the bone. Dislocations are more common, but if roentgenograms are made following reduction and before a cast is applied, more chip or avulsion fractures of this bone will be recognized.

The major blood supply of the os lunatum is received through the dorsal surface. A relatively minute fracture in this area with injury to the blood vessels can produce an avascular necrosis.

*Os Triquetrum:* Avulsion fractures of the dorsal cortex of the triquetral bone are common and have produced no significant late disability. This fracture can be easily seen in a lateral view but can only rarely be demonstrated in the anterior or posterior view. The fracture is recognized in the lateral view by the general appearance and location of the fragment; it can be conclusively proved to be a triquetral fracture if three "lateral views" are taken with a minimal variation from the true lateral. These multiple views will usually show the fractured surface of the bone and by parallax the fragment can be further localized to the triquetral area.

*Os Pisiforme:* Fractures of the pisiform bone are the result of a direct impact or of an accident involving power tools. No disability from the osseous injury has been observed.

*Os Multangulum Major:* Fractures of the greater multangular bone are relatively rare. Chip fractures have been associated with injuries to the first metacarpal bone. Additional fractures have been the result of power-cutting tools. Disability has resulted from the associated injury to the tendons and soft tissues.

*Os Multangulum Minor:* An isolated fracture of the lesser multangular bone has not been recognized in the writer's experience. The only fractures of this bone have been compound fractures following an extremely severe industrial accident and gunshot wounds, with extensive injury to many bones and soft tissues.

*Os Capitatum:* The capitate bone is a large strong bone which is protected to a large extent by surrounding bones. The author has recognized only a small chip fracture of the proximal surface associated with a fracture of the navicular. A navicular-capitate fracture syndrome has been reported in which there is a fracture of the waist of the navicular bone and the

proximal third of the capitate bone. The fracture line is essentially continuous through both bones and is the result of a severe impact from the radial styloid process against the carpal bones following a fall on the oustretched hand. The proximal fragment of the capitate rotates so that the proximal articular surface approximates the fractured surface of the larger distal fragment. The proximal fragment is avascular and may be excised, leaving a wrist with good function.

*Os Hamatum:* Several fractures of the hamate bone have been seen. These have usually been associated with a dislocation or a fracture dislocation of the bases of the fourth or fifth metacarpal bones. There has been essentially no permanent disability.

## CONCLUSION

Meticulous roentgen technic with the free use of special views following clinical evaluation of the patient will reduce to a minimum diagnostic errors in the study of the carpal bones. By prompt and accurate diagnosis the radiologist can aid in the reduction of disability following fractures of these bones.

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## SUMMARIO IN INTERLINGUA

### Fracturas Del Ossos Carpal

Examines minimal de carpos vulnerate debe includer un projection postero-anterior con le mano in partial deviation ulnar, un projection oblique con le mano in pronation partial, e un projection lateral ver. Altere projectiones special es possibilemente indicate per le examine clinic.

Le ossos navicular es fracturate le plus communmente inter le ossos carpal. Si iste fracturas interessa le tuberculo, bon union sin incapacitate apparente pote esser expectate. Fracturas del tertio distal etiam se reuni usualmente con function excellente. In fracturas del tertio intermediari del osso un avascular fragmento proximal non es improbabile, sed mesmo in le presentia de iste complication, union ossee pote occurrer.

Fracturas del ossos lunate, triquetre, pisiforme, multangule (major e minor), capitate, e hamate es discutite brevemente.

Meticulose technicas roentgenologic con le libere uso de projectiones special post evalutation clinic del caso investigate va servir a reducer al minimo le errores diagnostic in le studio del ossos carpal.

# Some Significant Aspects of Fractures of the Calcaneus[1]

ARNOLD D. PIATT, M.D.

FRACTURES of the calcaneus comprise approximately 2 per cent of all fractures and 90 per cent of those occurring in the tarsal bones. The relatively poor overall results in these injuries have been mentioned by many authorities (1–8, 12, 13, 15, 17). In this brief presentation, we shall endeavor to remind radiologists of some of the more pertinent and significant aspects of calcaneal fractures and suggest more comprehensive x-ray studies and detailed interpretations. Our orthopedic confreres often feel that we contribute little to the situation when we merely report "a comminuted fracture of the calcaneus," and rightly so. Actually, the radiologist should play an important role in determination of the prognosis and treatment, as well as in the roentgen diagnosis.

The calcaneus is primarily cancellous in structure, its spongy character providing elasticity in weight-bearing. Architecturally, its trabeculae conform to the major lines of compression and traction stress to which the bone is normally subjected. The main trabecular lines of stress are directed downward and backward from the subtalar joint surfaces, and downward and forward from the strong lateral cortical buttress. The traction trabeculae pass backward from the lower border of the body of the bone, turning upward into the tuberosity, and are responsible for the levering strain when the tuberosity is pulled up by the tendo Achillis. In the long axis of the calcaneus, the trabeculae are, in the main, parallel to the axis of the bone. There is, however, a thick, strong, angled strut on the outer and upper side, surrounded by a thin brittle cortex and extending from the front of the bone to the posterior margin of the posterior subtalar joint. The sustentaculum tali on the

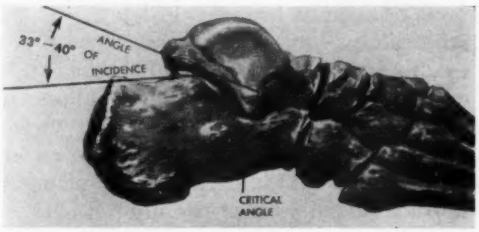


Fig. 1. Functional relations of the calcaneus. The tuber-joint and critical angles. (Copyright, Ciba Pharmaceutical Products, Inc. Moseley, H. F.: Traumatic Disorders of the Ankle and Foot. Ciba Clinical Symposia **7**: 167–194, November–December 1955)

axial view appears as a projection on the inner side, supported by a curved angle bracket of strong cortical bone.

The essential features of the os calcis in its relation to the talus are familiar. The *tuber-joint angle*, termed also the *salient angle*, the *angle of incidence*, and *Böhler's angle*, is the angle formed by the intersection of a line drawn from the posterior superior margin of the tuberosity to the high point of the posterior subtalar articular surface and a line projected along the subtalar articular surface extending from the anterior superior tip of the calcaneus to the same high point of the posterior subtalar articular surface. This angle normally has a wide variation, from 10 to 40°, the average being approximately 33 to 40°. In compression fractures with displacement of the tuberosity or subtalar articular surface, flattening of the angle occurs and it may even reach a negative or reverse phase, indicating the extent of the depression of the longitudinal arch. The *tuber-joint angle* should not be confused with the *crucial* or *critical angle*. The latter is the stress buttress on the lateral aspect of the subtalar articular surface which accommodates the spurlike wedge of the talus (Fig. 1).

Most of us, including myself, have often

[1] Presented as part of a Panel Discussion on Fractures, at the Forty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1956.

been satisfied with two plain studies of the os calcis, the lateral and the axial (plantar-dorsal) or tangential view, with which we are all familiar. Only recently have there been strikingly brought home to us the inadequacies of our purported roentgen examinations. We now feel that a study of the calcaneus is incomplete unless, in addition to the lateral and axial views, Anthonsen's oblique projection and an inversion-oblique radiograph are included. A Bucky axial view of the injured heel, as well as a comparison lateral film of the uninjured heel, is of considerable value. Anthonsen's oblique projection is obtained with 25° tilt of the tube to the foot of the table and a 30° angulation toward the toes, with the heel in a lateral plane and the foot dorsiflexed. The central beam is just below the medial malleolus of the tibia and passes in the direction of the long axis of the calcaneal sulcus. This view discloses to best advantage the posterior portion of the subtalar joint. For the inversion-oblique radiograph the foot is inverted so that the dorsum closely approaches the film and the central ray is at a right angle to the table top, passing through the midbody of the os calcis. This position demonstrates more readily fractures of the promontory or anterior lip of the calcaneus as well as tarsal bars, often obscured by the overlap of the lower anterior portion of the talus. One variation of the axial view which we prefer is the so-called "Harris" position, in which the patient, while standing, rests the injured heel on the film-holder and flexes the leg forward on the foot as much as possible. The tube is tilted 45°, with the central beam passing in a dorsal-plantar direction through the center of the body of the calcaneus. This examination allows for better visualization of the posterior subtalar articulation.

Several workers (8–14) have devised classifications of calcaneal fractures. Fundamentally similar, these stress two major categories, separating injuries according as they involve or do not involve the subtalar joint. Each major group has subgroupings dividing the types of fractures more critically. Suffice to say that most of the classifications were arranged with an eye to prognosis and modality of treatment as well as the anatomical principles relating to fracture lines and joint surfaces.

Any alteration in the physiological mechanics of the foot following a calcaneal fracture is subject to numerous factors. The principal elements involved are the maintenance of the fine balance of the articular surfaces, to carry the stress of body-weight in various positions, and the strength of the bone, depending on an intact cortical structure. Normally, the subtalar joint permits lateral tipping of the foot to adjust to uneven surfaces. In the majority of calcaneal fractures, the major impact usually falls on the posterior subtalar joint surface. Consequently the eventual function of the foot after this injury depends on what happens to the subtalar joint and how much secondary fixation is allowed to develop in the foot. A traumatic osteoarthritis may occur as a late complication, with prolonged disability, especially when the joint has been damaged and distorted.

When the injury causes upward displacement of the tuberosity, the site of the insertion of the Achilles tendon is also displaced upwards, which has the effect as of lengthening the tendon, causing difficulty in standing on tiptoe. There is also impairment of the normal heel and toe movement in walking, which is dependent on the power of the calf group of muscles. An excessive passive dorsiflexion of the ankle joint occurs concomitantly. When a broadening of the heel results from vertical crushing and lateral displacement of the outer bone fragment, a disability may result if there are associated malunion and excess bone formation beneath the tuberosity. Pain is most often present on weight-bearing or if a valgus derangement of the foot is the aftermath from this type of injury. Valgus deformity of the heel usually is due to displacement outward of a large postero-

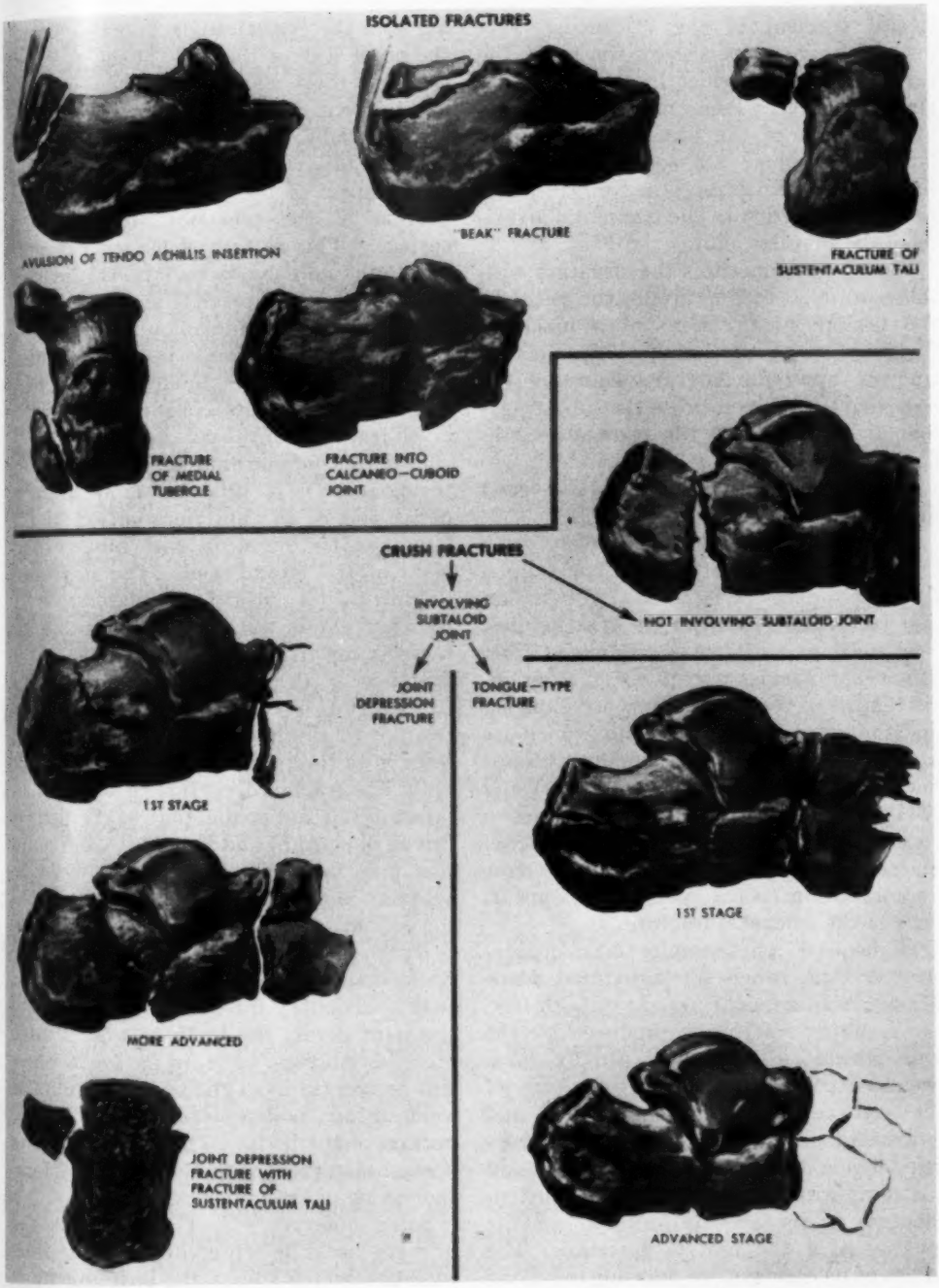


Fig. 2. The most common types of calcaneal fractures, indicating the so-called "isolated" fractures and the major categories of fractures which do and do not involve the subtalar joint. (Copyright, Ciba Pharmaceutical Products, Inc. Moseley, H. F.: Traumatic Disorders of the Ankle and Foot. Ciba Clinical Symposia **7**: 167–194, November–December 1955)

lateral segment of the calcaneus. Frequently there is persistent spasm of the peroneal muscles, which increases the valgus deformity. Pain may result from impingement of the tarsal bones on the lateral malleolus. On some occasions, a secondary arthritis of other tarsal joints results, in addition to the traumatic arthritis of the subtalar joint.

Steindler summarizes the situation with these words: "In fractures of the os calcis, the disability may not be so much to malunion as to the indirect effect of the fracture upon the lateral balance of the foot, due to involvement of the subastragaloid articulation and the traumatic arthritis which develops. The tendency to joint disintegration is lessened by good anatomical reposition."

Disabilities do not depend solely upon injury to the subtalar joint but also upon damage to the periarticular soft tissues and resultant fibrosis in these structures. Prolonged or even total disabilities from minor derangements can result from involvement of the ligamentous attachments and the synovial tendon sheaths which are in close proximity. A secondary stiffness may ensue if the foot has been markedly swollen or immobilized in plaster for a considerable period of time. Consequently, the degree of disability may have no correlation to the radiological appearance of the calcaneal fracture.

High-speed photography has demonstrated that, when an individual lands heavily from a height, on one or both feet, the resulting fracture is produced by the foot striking the ground, usually in a pronated position, with the tuberosity of the calcaneus outward, backward, and downward. Displacement of the tuberosity tends to be upward, forward, and outward, with the result that the sustentaculum is displaced downward and the long arch of the foot is flattened. The forces of momentum are transmitted along two routes, an outer and an inner. In the outer course, the posterior subtalar joint is immediately forced into eversion and the sharp outer taloid spur is driven like an axe into the crucial angle, splitting it and the outer wall of the bone along its grain; the inner route, along which the remainder of the force descends, passes through the anterior subtalar joint on to the sustentaculum tali, which may be sheared off the inner aspect of the body with the medial portion of the posterior subtalar joint surface. This pattern of fissuring is quite constant, with minor variations and subsidiary lines of cleavage (Fig. 2).

Needless to say, the amount of compression and comminution is in direct relation to the force of the momentum. There seem to be two fairly constant patterns of crush fractures of the calcaneus (8, 13, 17). The most common finding when the fracturing force is of sufficient momentum is depression of the anterior portion of the lateral major fragment, with bulging outward of the lateral wall. The depressed fragment lies inside the lateral wall. Another major fracture line may appear horizontally from the crucial angle to the posterior border of the tuberosity. The tuberosity is forced upward and backward relative to the body, becoming separated from it as the primary fracture line opens up. The fractured portion of the sustentaculum tali and medial part of the bone is driven downward and inward. Comminution may be so extensive that the entire subtalar joint may be shattered and even the cuboid joint may be involved.

In the other pattern of crush injury, the conformation is almost the same, except that a secondary fracture line runs behind the joint across the body so that a large piece of unbroken bone, which is the outer half or two-thirds of the posterior subtalar joint surface, is depressed into the spongy portion of the body. The tuberosity is in normal alignment with the body. A foreshortening of the calcaneus occurs.

Some observers (7, 17) feel that the primary break is represented by the fracture line which shears the sustentaculum tali and the medial portion of the posterior subtalar joint from the lateral part of the joint and the tuberosity, and that the other fracture lines are secondary. Often the

greatest deformity is on the medial aspect, with displacement of fragments and interposition of a brittle piece of cortical bone blocking anatomical reposition. A persistent prominence may be observed beneath the external malleolus, due to the deviation of the anterior spicule of the lateral fragment.

Occasionally a simple fracture of the calcaneus is overlooked. This fracture, involving the anterior superior margin of the os calcis or calcaneal promontory, results from either an acute exaggerated dorsiflexion of the foot or a combination of severe inversion of the foot with plantar flexion (16). The chip fragment in some instances fails to unite with the main body and a separate ossicle is formed which simulates a calcaneus secundarium. There is a subsequent loss of structural support because the dorsal calcaneocuboid and bifurcated ligaments are deprived of a solid anchorage. This in turn affects the long arch stress and may result in a traumatic pes planus. March fractures of the calcaneus are not infrequent. With a consistently painful heel following a history of a fall and initial negative roentgenograms, repeat studies in several weeks will demonstrate a healing fracture line which does not seem to extend through the cortex. It is of interest to know that in approximately 10 per cent of os calcis fractures sustained in falls from a height, there are associated anterior wedge fractures of the vertebral column, usually in the lumbar region.

In conclusion, it behooves us as radiologists to be more cognizant of the importance of our so-called "bread and butter" fractures. The realization that almost 40 per cent of calcaneal fractures require surgical intervention, and that long periods of convalescence may be necessary, indicates the necessity for our utmost effort to contribute to more successful results in these disabling injuries.

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SUMMARIO IN INTERLINGUA

## Aspectos Significative De Fracturas Del Calcaneo

Le duo simple studios radiologic del calcaneo que es communmente empleate—i.e. le projectiones lateral e axial—non suffice pro le adequate evalutation de vulneres calcaneal. Illos deberea esser supplementate per un projection oblique de Anthonsen e un roentgenogramma inversional-oblique, possibilemente etiam per un vista axial de Bucky del calce afficite e un exposition comparative del altere calce.

Le duo principal elementos afficite per alterationes del mechanica physiologic del pede post vulneres calcaneal es (1) le delicate balancia del superficies articular que debe esser mantenite pro supportar le stress del peso corporee in varie positiones e (2)

le fortia del osso que depende de un intacte structura cortical.

Incapacitates non depende exclusivemente de vulneres del articulation subtalar sed etiam de lesiones del histos molle periarticular e del consequente fibrose. Per consequente il pote occurrer que le grado de incapacitate monstra nulle correlation con le aspecto radiologic del fractura calcaneal.

Fracturas suffrite in caditas ab alte locos e fracturas a contusion e comminution es discutite.

Le observation que quasi 40 pro cento del fracturas del calcaneo require interventiones chirurgic e que longe periodos de convalescentia es un occurrentia non infrequente signala le necessitate de effortios extreme pro obtener bon resultatos in iste gruppo de casos.

# The Immediate Prognosis of Intracapsular Fractures of the Neck of the Femur[1]

PAUL A. JONES, M.D.

THE ROLE OF THE radiologist in the immediate prognosis of intracapsular fractures of the femoral neck is highly important in the small community hospital. Unfortunately, in many areas, the radiologist, by his indifference, has relegated himself to a position of relative unimportance. Often he is consulted only after the operative procedure, when his opinion is of no value in regard to the immediate prognosis.

In many of our training institutions, basic instruction in orthopedic radiology is limited to reconstructive surgery rather than the acute "run-of-the-mill" problem of the small hospital. There has been a complete lack of intellectual curiosity as to the everyday problems of orthopedic radiology. In the small general hospital, the radiologist should and must assume the responsibility of being the authority in this field, especially since many of these problems are handled by non-orthopedists. In our opinion, the radiologist should be the focal figure in the planning stage of the reduction and at the time of its actual performance. He should be available to view all films at the time of operation. His very presence will insure against the acceptance of anything less than an adequate reduction. This is particularly true where a goodly percentage of fractures are treated by general surgeons and others, as is the case in our community.

The following points are of value in determining the prognosis of intracapsular fractures of the femoral neck prior to reduction:

1. Angle of fracture.
2. Type of fracture:
   (*a*) Abduction type.
   (*b*) Adduction type.
3. The degree of demineralization.
4. The degree of comminution of the medial portion of the distal fragment.

Variations in the angle of fracture are represented by the following groupings (1):

*Group I:* The fracture line is less than 30° to the horizontal. Prognosis is good even without internal fixation.

*Group II:* The fracture line is 30 to 50° to the horizontal. Here accurate reduction and perfect internal fixation are required.

*Group III:* The fracture line is 50 to 90° to the horizontal. The prognosis is unfavorable even with accurate nailing.

These fractures are further subdivided into the abduction and adduction types (2, 3, 4). The abduction fracture is defined as one that causes the upper portion of the femoral shaft and neck to shift downward and medially. The result is that the femoral head is thrown toward valgus, and the medial portion of the neck fragment comes to lie inside the medial portion of the head fragment. This fracture carries a good prognosis.

In the adduction type the femoral neck tends to go upward and lateral to the head, twisting the head toward varus and shifting the inner (medial) portion of the neck fragments slightly above and to the outside of the medial portion of the head fragment. This fracture, even if impacted, must be transformed to an abduction type; otherwise the prognosis is poor.

In our experience, extreme demineralization has resulted in a poor prognosis. There is an inherent tendency to poor callus formation. Due to the thinness of the cortical bone, it is almost impossible to obtain an adequate purchase by the nail. Even with accurate reduction and perfect

[1] Presented as part of a Panel Discussion on Fractures, at the Forty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1956.

nailing, the prognosis must be guarded if not definitely poor. The unfavorable result here may be due in part to under-reduction, as most of these patients are extremely poor operative risks.

In the presence of severe comminution of the medial margin of the neck and shaft fragment, union is definitely poor. Such fractures, of course, are both intracapsular and extracapsular. We have seen them only in automobile accidents in which there has been extreme trauma.

It is our contention that an interested third party, namely the radiologist, should be present and pass judgment on all films of intracapsular fractures of the femoral neck while the reduction is being attempted.

Technically, films should be obtained in a uniform manner. The anteroposterior view should always be taken with the limb in complete internal rotation. The lateral views should never be obtained by frogging the leg. A set of test films should be obtained prior to the actual operation to insure radiographs of proper diagnostic quality at the time of the procedure.

It is our plea that those in charge of resident training programs acquaint their trainees with the fundamental problems of the general radiologist. A working arrangement with a radiologist in a small community hospital for a short period during training is desirable.

In summary, the following points must be considered by the radiologist in arriving at the immediate prognosis of intracapsular fractures of the femoral neck: angle of fracture, type of fracture, degree of demineralization, and degree of comminution of the medial margin of the neck and shaft fragment.

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## SUMMARIO IN INTERLINGUA

### Le Prognose Immediate De Fracturas Intracapsular Del Cervice Femoral

Le rolo del radiologo in le prognose immediate del fracturas intracapsular del cervice femoral es del plus grande importantia. Ille debe esser le persona focal in le planation del reduction e debe esser disponibile pro examinar omne pelliculas al tempore del operation.

Quatro factores principal determina le prognose de iste fracturas:

1. Le angulo del fractura. In casos de fractura de minus que 30 grados per rapporto al horizontal le prognose es bon mesmo sin fixation interne. In casos de fractura de inter 30 e 50 grados per rapporto al horizontal, accurate reduction e perfecte fixation interne es requirite. Quando le angulo del fractura excede 50 grados, le prognose es disfavorabile.

2. Le typo de fractura. Fracturas de abduction ha un bon prognose. In fracturas de adduction—a minus que illos pote esser transformate in le typo de abduction—le prospecto es pauco favorabile.

3. Dismineralisation. Extreme dismineralisation es un factor disfavorabile.

4. Comminution. In le presentia de sever grados de comminution del margine medial del collo del femore e del fragmento de su diaphyse, le prospecto del union successose es definitemente nigre.

# Colonic Endometriosis: Roentgenologic Aspects[1]

FRED K. WIETERSEN, M.D., and ROSS M. BALOW, M.D.

INVOLVEMENT of the colon by endometriosis is not an unusual occurrence. According to Cullen, about one-half of all extensive cases will show some form of intestinal involvement. Meigs pointed out, more than fifteen years ago, that endometriosis was definitely increasing in frequency; therefore, more pelvic complications were to be expected. It behooves the physician to bear in mind the possibility that a given colonic lesion may represent endometriosis. The radiologist should exert great caution in distinguishing between this condition and carcinoma or inflammatory disease, and should carefully correlate his findings with the clinical and laboratory evidence.

Endometrial lesions may occur in the serosa of the appendix, cecum, sigmoid, rectum, mesentery, or epiploic appendages. It is believed to result from retrograde menstruation through the fimbriated end of the fallopian tube, with implantation of bits of endometrial tissue on adjacent structures such as the lateral surface of the ovary and the peritoneum in the posterior cul-de-sac. Thus the peritoneal surfaces of the uterus, tubes, and intestine become involved, and subsequently the rectovaginal septum. The implants become adherent and growth proceeds. The peritoneum resists invasion and reacts in an inflammatory-like manner, giving rise to typical "shotty" indurations which are palpable on pelvic examination. The implants never produce endometrial cysts of any size, such as are seen in the ovary. They do, however, rupture and spread the disease.

In contradistinction to primary carcinoma, endometriosis grows from the outside in. Most often it occurs as a harmless plaque or implant. The bowel, however, may become adherent and then twist, with consequent stenosis or obstruction. Occasionally, invasion takes place to such an extent that the entire bowel wall is involved, including the mucosa, and varying degrees of obstruction may result.

These endometrial lesions naturally display cyclical, features related to the menstrual cycle and regress at the menopause, leaving a puckered scar. Resection is rarely required. The sigmoid at the level of the cul-de-sac is most often involved. The appendix may be invaded but appendicitis never results.

It is difficult to assess accurately the incidence of obstructing endometriosis of the colon. Many lesions undoubtedly involve the rectosigmoid without producing constriction, stenosis, or obstruction. Of Jenkinson and Brown's series of 47 patients with rectosigmoid involvement, 21 had symptoms of some degree of obstruction. It would thus appear that endometrial disease of the colon occurs more commonly than has been suspected. It is undoubtedly true that it is frequently overlooked because other symptoms and signs of pelvic endometriosis are more prominent and draw attention away from the possibility of bowel involvement. Many times the menopause automatically terminates the disease process, and it is never discovered. Cases have been reported, however, in post-menopausal women. Most of the colonic lesions have been discovered at surgery and not by roentgenologic study. It is quite natural, therefore, that little has appeared on the subject in the radiologic literature.

The signs and symptoms of colonic endometriosis are to a great extent similar to those in other forms of pelvic endometriosis. The gastrointestinal symptoms vary, depending upon the extent of involvement of the bowel wall and the degree of narrowing.

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[1] From the Department of Radiology, The Grace Hospital, Detroit, Mich. Accepted for publication in July 1957.

Patients are usually between thirty and forty years of age and report a rather long duration of symptoms, averaging close to three years. Sterility is a common characteristic, as in other types of endometriosis. Likewise there is a considerable incidence of menstrual abnormalities, as high as 80 per cent in some series, dysmenorrhea being the most common complaint.

The patient usually gives a long history of bowel symptoms, which may or may not point to some degree of obstruction or malfunction. Most frequently there is a history of progressive constipation, with pain in the lower abdomen. Pain with bowel movements, cramps, and diarrhea may occur in association with menstruation. Flatulence, abdominal distention, and bloating are observed. These symptoms often show exacerbation just before and during the menstrual period.

The complications of colonic endometriosis may range from minimal, or none, to severe, depending on the degree of involvement. If the bowel wall is involved to a minor extent only, sigmoidoscopy may reveal nothing. On the other hand, the mucosa may be injected, congested, red, and puckered. It is seldom ulcerated, however, so that biopsy is not obtained. It is because of this lack of mucosal ulceration that rectal bleeding is so rare. If ulceration does occur, carcinoma can be

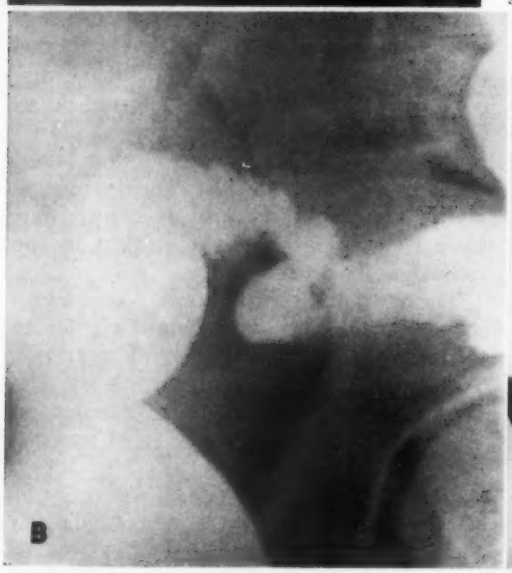



Fig. 1. Case I. A. Supine abdominal roentgenogram revealing abnormally distended cecum, ascending colon, transverse colon and descending colon. Note narrowed sigmoid.

B. Roentgenogram made in June 1952, revealing normal sigmoid colon.

C. Roentgenogram made in August 1952, demonstrating long, stenotic sigmoid lesion due to endometriosis.

ruled out by biopsy. There is no loss of weight or wasting. The blood picture usually is relatively normal except where there is significant loss from the menstrual abnormality.

Despite the general impression that the barium enema is of little value in the diagnosis of colonic endometriosis, we feel that there are certain significant roentgenologic signs which, when correlated carefully with the clinical picture, will contribute materially to the diagnosis of this disease process.

## CASE REPORTS

CASE I: Mrs. R. M., a 43-year-old white housewife, gravida II, para II, was admitted on Aug. 3, 1952, because of pain in the left lower quadrant. She had had intermittent attacks of rather severe left-lower-quadrant pain, radiating to the left costovertebral angle and the upper left quadrant, for some four to six months prior to admission. There had been no weight loss or change in bowel habits. A barium-enema examination in June 1952 had been reported normal. A hysterectomy had been performed three years earlier because of irregular uterine bleeding.

Physical examination on admission was essentially negative except for some pain in the left lower quadrant. Roentgen examination, including a barium-enema study, showed a lesion in the sigmoid measuring 8 cm. in length, beginning and ending abruptly, producing concentric narrowing of the lumen almost to the point of complete obstruction. The mucosa was intact but distorted. Tenderness was noted on fluoroscopy.

Operation was performed on August 8 and the involved area of the bowel was resected. The final pathological report indicated endometriosis involving the colon.

CASE II: Mrs. R. C., a 50-year-old white housewife, was admitted to the hospital for "gallbladder trouble." A week prior to admission she had become nauseated and vomited several times. The next morning she experienced pain in the right flank, radiating posteriorly into the back. There was a history of several similar episodes in recent months. No change in bowel habits was noted.

Physical examination was essentially negative. A right ovarian cystectomy had been performed twenty-nine years earlier, and an appendectomy several years prior to admission. The menopause had occurred five years previously. A barium enema demonstrated a polypoid defect, 3.0 × 3.5 cm., on the lateral aspect of the cecum. The mucosa was intact. There was no tenderness on fluoroscopy.

An exploratory laparotomy revealed extensive adhesions throughout the abdomen and pelvis. Numerous endometrial implants were present on the cecum, causing the lateral defect in the cecal wall. No surgery was performed on the bowel.

Fig. 2. Case II. Polypoid endometrial lesion on lateral border of cecum.

CASE III: Mrs. L. W., a 42-year-old white woman (gravida 0), entered the hospital complaining of epigastric pain and vomiting. For the past three weeks she had experienced a progressively severe sharp epigastric pain, associated with frequent episodes of vomiting. She had eaten very little in this period and had lost 14 pounds. She gave a history of mid-cyclic vaginal bleeding for the past two years. An appendectomy had been done previously.

Physical examination revealed slight tenderness in the right lower quadrant and a hard movable mass in the suprapubic region. The uterus was enlarged and anteverted, with two or three nodules on its surface. No other abnormal physical findings were present. A barium-enema study revealed a polypoid defect, 4 cm. long, involving the sigmoid wall and displacing the mucosa.

An anterior resection of a portion of the sigmoid colon was done. Pathologic examination of the specimen revealed endometriosis and a benign polyp of the colon.

CASE IV: Mrs. M. B., a 34-year-old white housewife, was admitted to the hospital with intermittent crampy right-lower-quadrant pain and a history of four years of menstrual irregularities. On physical examination no abdominal masses were felt. A pelvic examination revealed a right ovarian cyst.

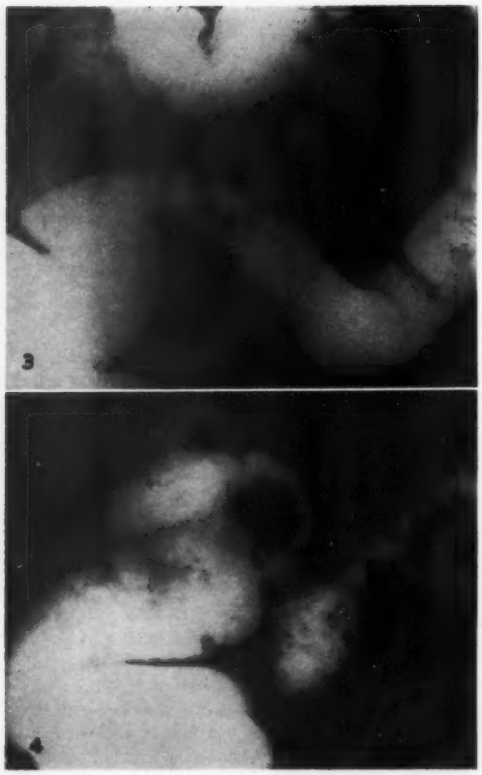

Fig. 3. Case III. Polypoid endometrial sigmoid deformity.
Fig. 4. Case IV. Sigmoid infiltration, polypoid in nature, due to endometriosis.

At operation, Feb. 1, 1954, extensive pelvic endometriosis was found. Five inches above the rectosigmoid junction was a constricting lesion. Ten days later a barium-enema study revealed a polypoid mass, 3.5 cm. in length in the sigmoid area. The mucous membrane was intact but displaced by an eccentric mass obviously involving the wall. There was no tenderness on fluoroscopy.

On Feb. 15, an anterior resection of the sigmoid colon was done. The final pathological report was endometriosis involving the wall of the sigmoid colon with considerable thickening of the wall between the serosa and mucosa; mucosa intact.

CASE V: Mrs. I. J., a 39-year-old white housewife, gravida II, was admitted to the hospital in October 1955 with menorrhagia of four months duration. Physical examination revealed a mass in the hypogastrium but was otherwise negative. A barium-enema study, Oct. 17, 1955, demonstrated a constricting lesion in the sigmoid colon. This measured 6 cm. in length, beginning abruptly but ending with a gradual transition to normal tissue. The mucous membrane was intact but distorted. There was no tenderness on fluoroscopy.

At operation, Oct. 20, a right ovarian cyst was removed. The sigmoid colon was bound to the uterus posteriorly. On Oct. 26, after bowel preparation, an anterior resection of the colon was performed. The final pathologic diagnosis was endometrioma of the colon, involving serosa, muscularis, and submucosa.

CASE VI: Mrs. H. S., a 44-year-old white housewife, gravida 0, was admitted in November 1955, having had no bowel movements for ten days. She complained also of generalized crampy abdominal pain, which had become progressively worse, and of abdominal distention. There had been no vomiting. Menstrual periods had been irregular for a year, with

Fig. 5. Case V. Concentric, partially stenosing, endometrial sigmoid lesion.

menorrhagia. The patient had previously been well.

Physical examination was essentially negative except for abdominal distention and some increase in bowel sounds. On Nov. 15 sigmoidoscopy was performed to 10 cm., where a hard, obstructing mass was encountered, which was thought to be carcinoma. A transverse colostomy was done on the same day. A barium enema on Nov. 26 revealed a constricting lesion in the rectosigmoid, 6 cm. long, producing almost complete obstruction. It began smoothly but terminated abruptly. The mucosal pattern was distorted. There was no tenderness on fluoroscopy.

An anterior resection of the rectosigmoid was

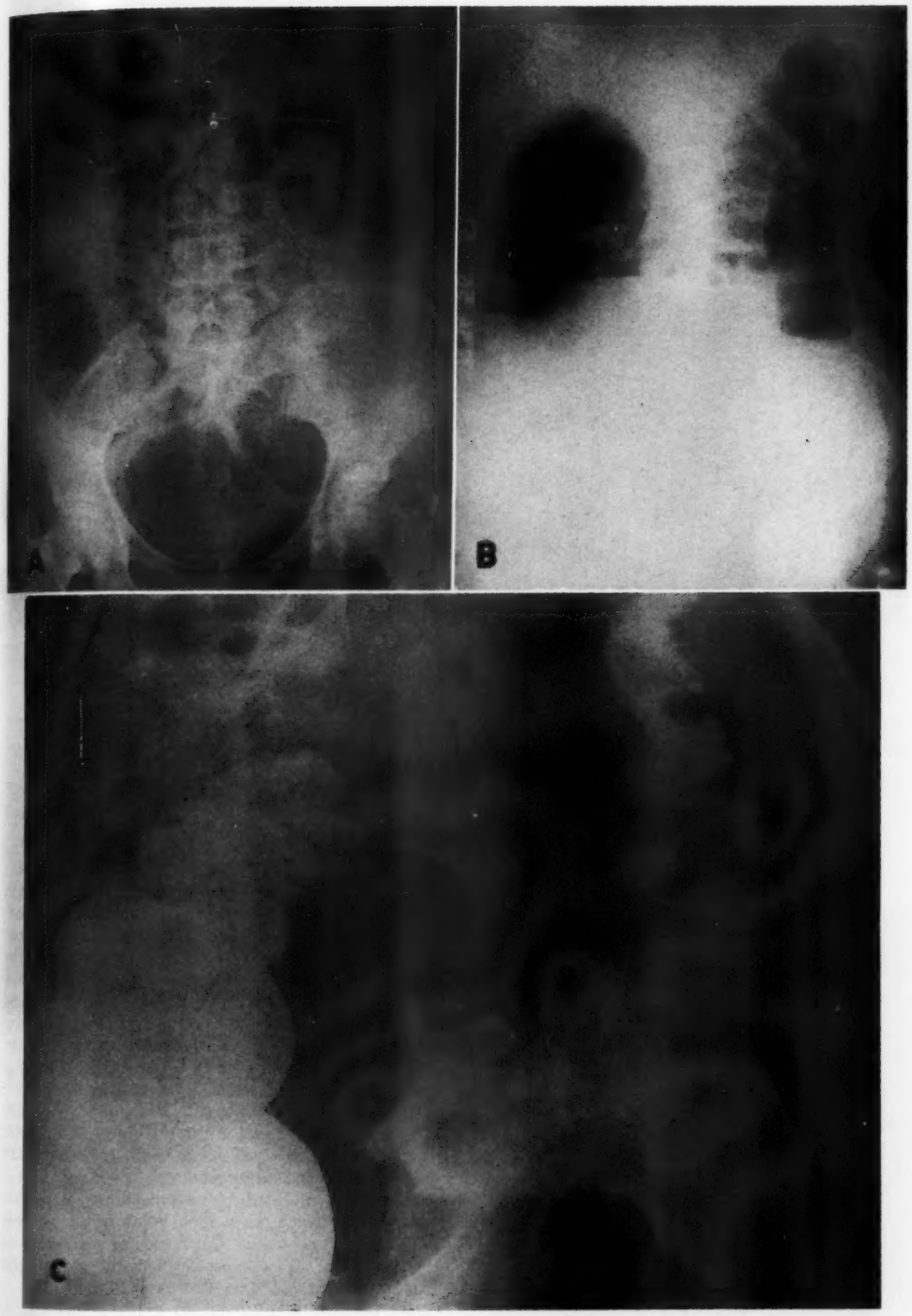


Fig. 6. Case VI. A. Supine plain roentgenogram showing abnormal gaseous distention of colon. Small bowel also inflated.

B. Upright abdominal roentgenogram showing fluid levels in cecum, transverse colon, and descending colon. Obstruction obviously in distal descending colon or sigmoid.

C. Long, concentric, stenotic sigmoid endometriosis.

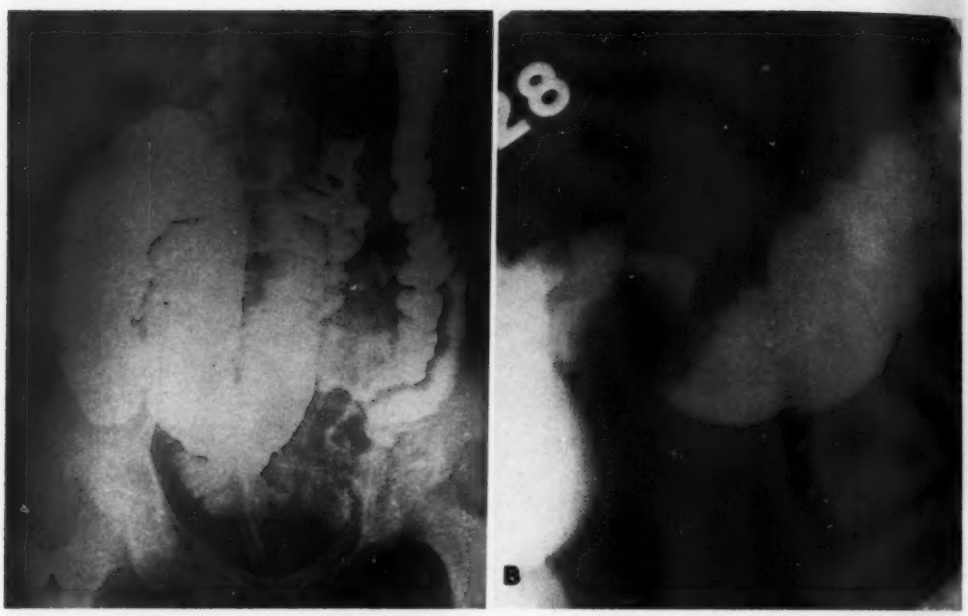

Fig. 7. Case VII. A. Supine abdominal roentgenogram depicting distended barium-outlined colon due to sigmoid obstruction.
B. Short, stenotic sigmoid segment involved by endometriosis.

done. The pathological diagnosis on the removed colonic tissue was endometriosis.

CASE VII: Mrs. H. P., a 41-year-old white housewife, gravida III, was admitted to the hospital for a hysterectomy because of menometrorrhagia of nine months duration, with some associated low back and abdominal pain. There had been no change in bowel habits. A pelvic mass was found on physical examination and was felt to represent a fibroid uterus. Before surgery a routine barium-enema study was done, and this demonstrated an annular constricting lesion in the sigmoid, 3 cm. long, beginning and ending abruptly, producing almost complete obstruction. The mucous membrane was preserved but distorted. There was no tenderness on fluoroscopy.

A segmental resection of the sigmoid colon was done. The pathological diagnosis was endometriosis.

CASE VIII: Mrs. F., a 46-year-old white factory employee, was readmitted to the hospital in March 1956 following a recheck barium enema study which had revealed a polypoid defect in the sigmoid area. A sigmoid resection had been done two years earlier for adenocarcinoma, Grade II. The patient had had no bowel complaints since that time. One year prior to admission a curettage was performed for vaginal bleeding. No evidence of cancer was found. Roentgen examination revealed an intraluminal polypoid defect in the sigmoid, measuring 3.0 × 3.5 cm., flat and sessile. No fixation was evident on fluoroscopy.

At operation an endometrioma invading the wall of the sigmoid colon was found. This was proved pathologically.

CASE IX: Miss J. G., a 21-year-old white student, was admitted to the hospital complaining of dull low back pain, intermittent sharp left lower quadrant pain, and constipation of one year duration. The back pain was worse immediately following the menstrual periods, which were normal. There was no history of rectal bleeding. Except for a palpable left lower quadrant mass, the physical examination was negative. A barium-enema examination revealed a narrowed segment in the proximal sigmoid colon, 7.5 cm. long, thought to be due to extrinsic pressure. The narrowing was concentric, beginning smoothly and ending abruptly in normal tissue. There was no mucosal destruction. No tenderness was apparent on fluoroscopy.

Operation revealed an endometrioma of the left ovary, over which the sigmoid colon passed and was adherent. The serosa and muscularis appeared to be involved. This was verified by pathological examination.

## DISCUSSION

In our series two main types of lesion were demonstrated, namely, a polypoid

Fig. 8. Case VIII. Intramural polypoid endometrioma located in sigmoid.

lesion involving the wall and a constricting, stenosing lesion producing varying degrees of obstruction. Although the defects produced by endometriosis are similar in certain respects to those of primary carcinoma and, to a lesser degree, of inflammatory disease, there are certain characteristics which should aid in the differential diagnosis. The polypoid lesion involves the wall of the bowel, displacing and distorting the mucous membrane but not destroying it. Constricting, stenosing lesions also exhibit an intact mucous membrane despite the marked degree of obstruction to the lumen. The bowel, as a rule, is fixed. It is usually nontender between menstrual periods. Tenderness may be expected during or about the time of menstruation, because of the cyclic nature of the disease. We would also expect some changes in the size and appearance of the lesion, although we were not privileged to make this observation in our cases. In contrast to certain other series, our patients exhibited no particular change in bowel habits and only minimal evidence of possible bowel disease. It is quite evident that colonic endometriosis must be differentiated from inflammatory and neoplastic disease. Endometriosis occurs chiefly in the age group, twenty-five to forty-five. There is seldom any loss of weight. Menstrual disorders and pelvic pain are common. Symptoms are often of long duration. Sterility is a frequent accompaniment. The carcinoma patient is usually older, with loss of weight, anemia, and blood in the stool. Symptoms are of relatively short duration. There is no pain or tenderness. The colonic defect is short,

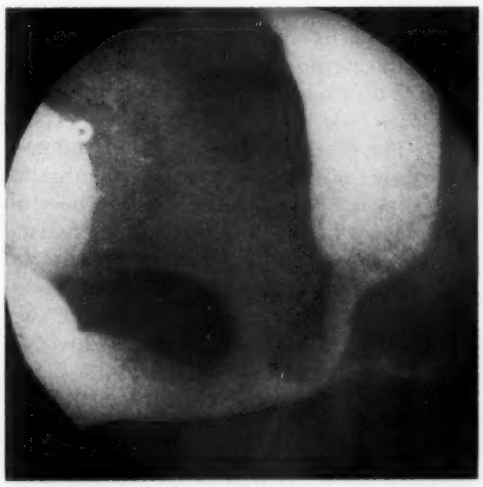

Fig. 9. Case IX. Smooth, concentric sigmoid lesion.

begins and ends abruptly, and the mucosa is destroyed. There is no change in the appearance of the lesion during the menstrual cycle.

Inflammatory disease produces pain, tenderness, fever, and leukocytosis. There may be a palpable colonic mass. The patient is in the older age group and exhibits no loss of weight or anemia. Periodic pelvic signs and symptoms should not be present. The colonic defect is long, smooth both proximally and distally, with the mucosa intact but possibly distorted. There is evidence of spasm and tenderness.

## SUMMARY

1. Endometriosis must be differentiated from carcinoma and inflammatory disease in order to obviate unnecessary surgery.

2. Colonic endometriosis involves chiefly the rectosigmoid area but other segments of the bowel may be invaded.

3. Endometriosis must be borne in mind as a possibility in any female with obstructive symptoms.

4. Colonic endometriosis may be camouflaged by other symptoms and signs of pelvic endometriosis.

5. We believe that, with more frequent roentgen study of the colon, the incidence of endometriosis will be found to be higher than has been suspected.

6. Since exaggeration of signs and symptoms is likely to be associated with the menstrual period, it would seem advantageous to do a barium-enema examination at this time.

7. The chief roentgen signs of endometriosis are: (*a*) intact mucous membrane; (*b*) fixation; (*c*) absence of tenderness on fluoroscopy before or after the menstrual period; (*d*) colon otherwise normal; (*e*) a concentric, stenosing, or polypoid lesion; (*f*) usually sharp demarcation, in the case of concentric lesions; (*g*) obvious involvement of the wall of the bowel if the defect is polypoid; (*h*) usually short length (over 6 cm in only 2 cases.); (*i*) exacerbations of findings at the menstrual period.

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SUMMARIO IN INTERLINGUA

**Endometriosis Colonic: Aspectos Roentgenologic**

Endometriosis del colon es probabilemente un occurrentia plus commun que lo que es generalmente credite, proque illo es frequentemente mascate per signos e symptomas de endometriosis pelvic. Illo affice principalmente le rectosigmoide sed pote invader altere segmentos del intestinos.

Le lesiones es de duo typos: un lesion polypoide e un lesion de stenose concentric que resulta in varie grados de obstruction. Le lesiones concentric es usualmente characterisate per un demarcation distincte. Le lesiones polypoide monstra obvie affectiones del pariete intestinal. Differentiation ab morbo inflammatori e carcinoma es importante a fin de evitar interventiones chirurgic que es innecessari. Resection del lesiones endometric es un requirimento rar.

Studios a clyster de barium se ha provate utile in le diagnose. Le aspectos significative include le sequente: un mucosa intacte que nonobstante es frequentemente distorquite; fixation; absentia de sensibilitate sub pression excepte in association con le periodo menstrual (quando omne le symptomas es exaggerate); e affection de solmente un curte segmento del intestino con normalitate del resto del colon.

Es reportate nove casos.

# Postbulbar Duodenal Ulcer[1]

S. A. KAUFMAN, M.D., and GEORGE LEVENE, M.D.

PEPTIC ULCER of the duodenum involving the postbulbar region presents important clinical and radiographic differences from the usual type of duodenal ulcer. It has been our experience that this type of ulceration is not a rarity, but occurs frequently enough to be given careful consideration in every patient undergoing gastrointestinal examination.

The clinical findings in postbulbar duodenal ulcer do not differ significantly from those associated with the more commonplace ulcers of the bulb. It is important, then, for the radiologist to localize the site of ulceration accurately so that the clinician is better able to evaluate the future course and management. Bleeding occurs in 57 per cent of postbulbar ulcers, which is in striking contrast to the 19 per cent of bulbar ulcers and 23 per cent of gastric ulcers (1). This high incidence of bleeding, coupled with an increased frequency of intractability to treatment, makes the prognosis rather poor and demands special therapeutic considerations.

The actual incidence of postbulbar ulcers is obviously impossible to determine. Various authors (2–4) note that 5 to 20 per cent of peptic ulcers found at autopsy are postbulbar, while 5 per cent of radiologically demonstrated duodenal ulcers are located distal to the bulb. It is our feeling that postbulbar ulcers are far more common than these figures indicate. Indeed, we would be inclined to agree with previous reports (5) that they are at least as common as gastric ulcers. We are

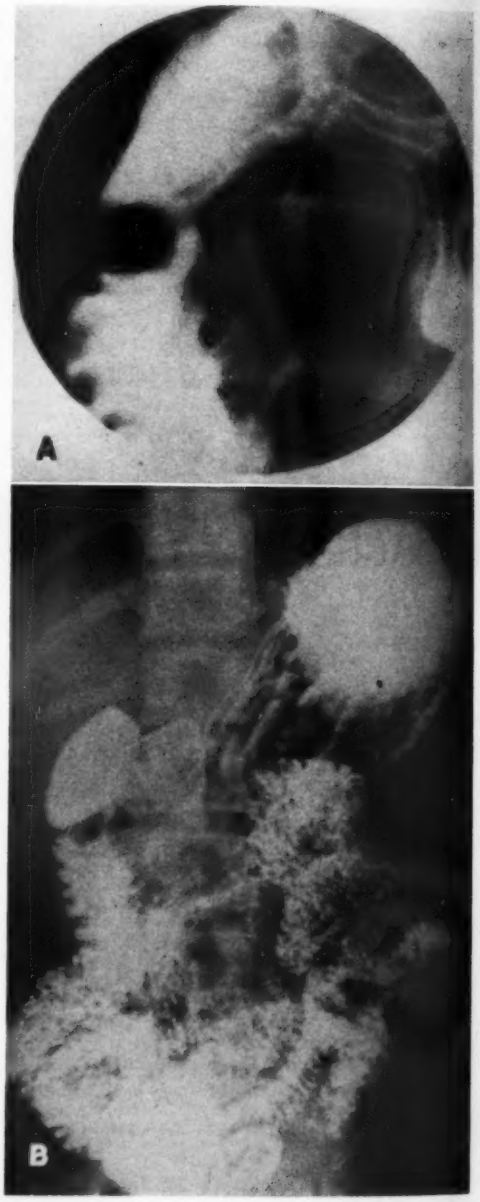


Fig. 1. A 16-year-old male admitted to the hospital because of severe gastrointestinal bleeding. A. Typical deformity of the descending duodenum due to a postbulbar ulcer. There is a large blood clot in the first portion of the duodenum. B. Anteroposterior projection showing the antrum of the stomach overlying the lesion of the duodenum. →

[1] From the Departments of Radiology of the Massachusetts Memorial Hospitals and Boston University School of Medicine, Boston, Mass. Accepted for publication in July 1957.

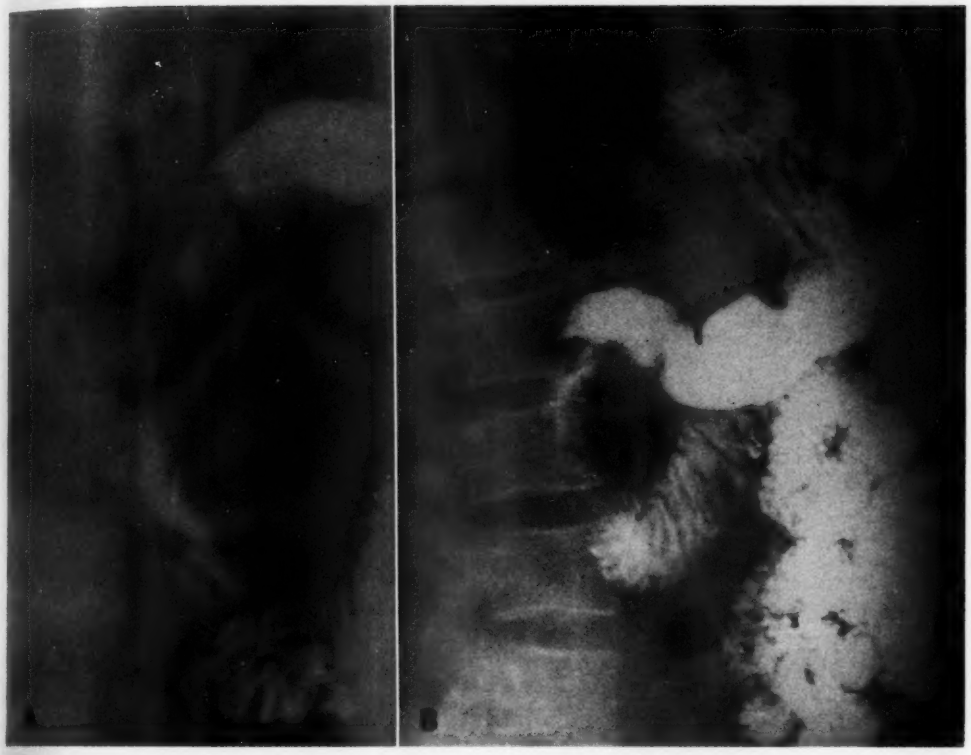

Fig. 2. Large ulcer crater in the descending duodenum. A. Marked spasm of the intestine adjacent to the ulcer. The normal mucosal pattern is obliterated by edema. B. Six weeks later the duodenum shows asymmetrical narrowing just below the cap and spasm of the lumen distal to the ulcer. The patient had been placed on a strict medical regime, with improvement of his symptoms.

concerned in this report with ulcers occurring in the second or descending portion of the duodenum. This differentiates them from ulcers found in the first portion of the duodenum or "bulb," which are relatively common, and from ulcers of the more distal portion of the duodenum, which are extremely rare.

The radiographic findings in postbulbar ulcers are characteristic. There is asymmetrical localized narrowing of the descending duodenum due to sustained spasm of the wall opposite the ulcer crater (Fig. 1). Duodenal spasm is seen in almost every case and is probably the most constant finding. Even in patients in whom the ulcer crater is not demonstrable, this asymmetrical narrowing, if constant, is almost sufficient evidence for a diagnosis if the clinical findings are consistent. The ulcer crater is usually well demarcated in the proximal two-thirds of the descending duodenum, in the immediate vicinity of the ampulla of Vater. It seems to show a predilection for the medial wall. The area adjacent to the ulcer often shows evidence of irritability and the mucosal pattern may be distorted by edema and inflammation. Occasionally, the entire descending duodenum is in spasm, and a definite diagnosis can be made only by identifying the ulcer crater (Fig. 2).

The duodenal bulb shows no constant findings. Although previous reports stress the frequent association of bulbar and postbulbar ulcer (6), we have not found their coexistence frequent. In our cases, the bulb itself was most often normal or patulous. Ball, Segal and Golden (2), however, in an excellent review of the subject stated

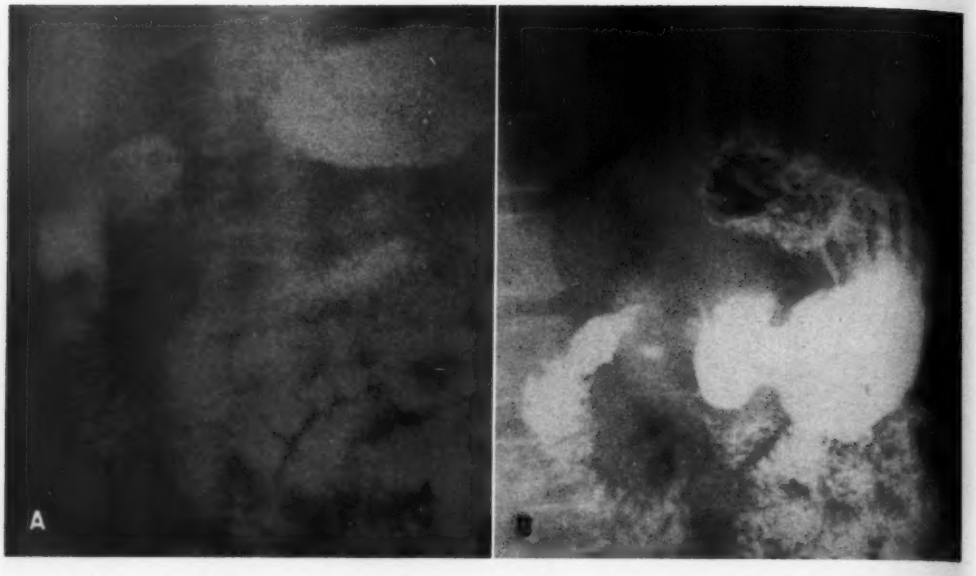


Fig. 3. Postbulbar ulcer in a 46-year-old male with an ulcer history of six years. During the past year he had been refractory to treatment. Following a subtotal gastrectomy he was free of ulcer symptoms. A. Asymmetrical narrowing of the descending duodenum with a well demarcated ulcer crater on the medial wall. B. The lesion of the second portion of the duodenum is obscured by the barium-filled duodenal cap.

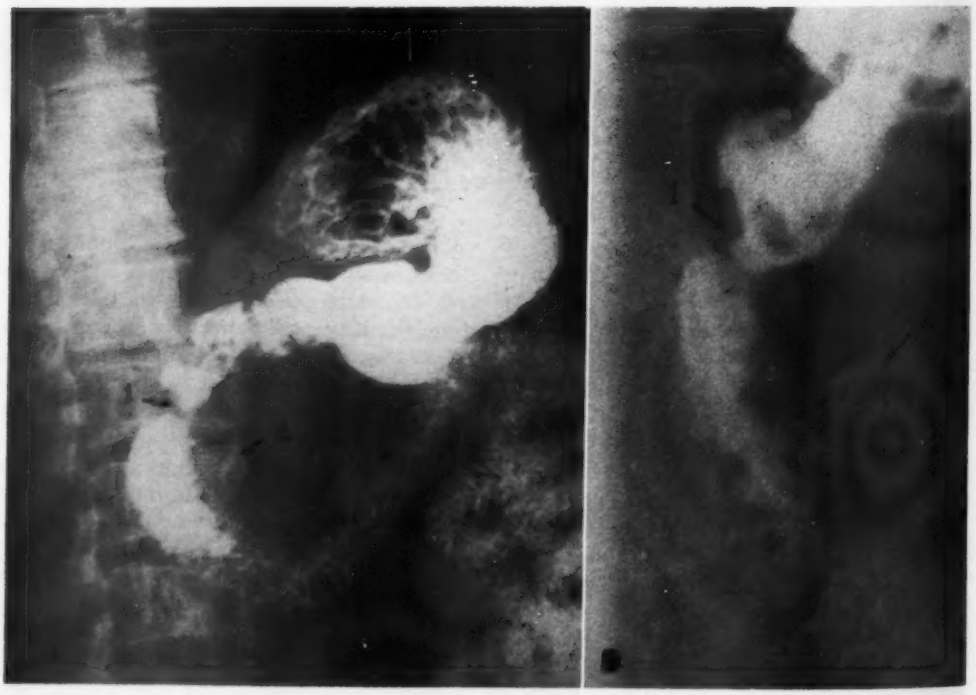


Fig. 4. Postbulbar duodenal ulcer in a 55-year-old male suffering from severe ulcer symptoms for several years. The patient underwent a subtotal gastrectomy with relief of symptoms. A. Deformed descending duodenum due to an ulcer (1); a small diverticulum (2). B. Close-up of duodenum showing asymmetrical spasm, ulcer crater (1), and diverticulum (2).

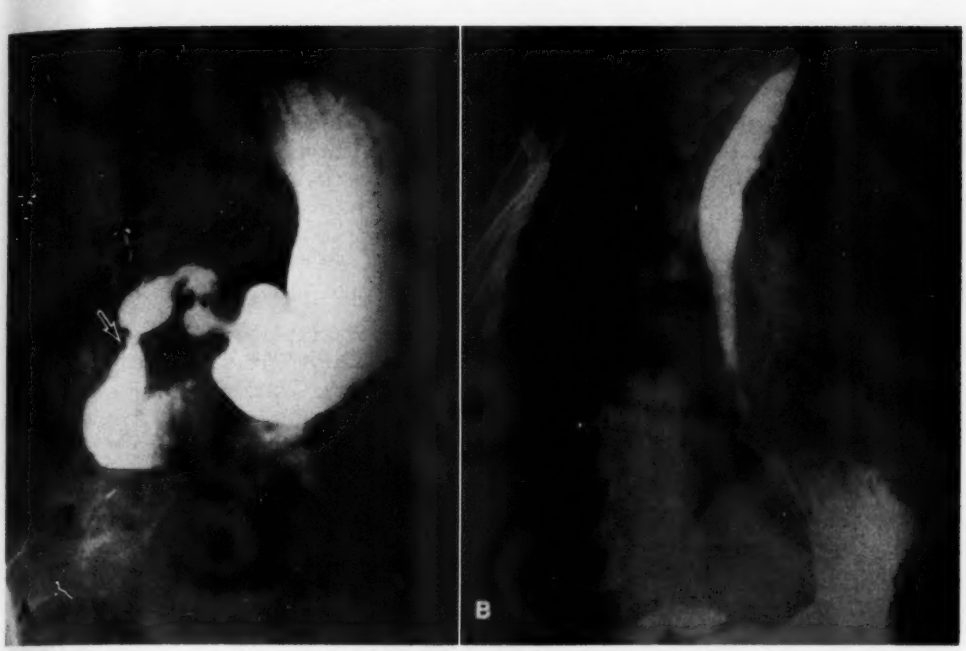


Fig. 5. Thirty-four-year-old female with scleroderma of many years duration. Ulcer-like symptoms developed five weeks prior to examination. A. Marked narrowing of the descending duodenum with an ulcer crater seen on the outer wall. The symmetrical nature of the stenosis was thought to be attributable to a scleroderma lesion. B. Esophagogram showing characteristic scleroderma changes.

that all of their cases showed irritability of the duodenal bulb. This change was probably secondary to the ulcer crater in the descending portion and did not necessarily mean ulceration of the bulb itself.

The technic of the examination is important. Due to the frequently associated pyloric spasm and irritability of the duodenum, careful study of the second portion of the duodenum may be neglected. In the upright and even in the supine or prone position, this segment of the intestine may be obscured by the antrum of the barium-filled stomach (Fig. 1) or by the duodenal cap (Fig. 3). It has been our experience that, once the duodenum is filled, the most advantageous projection is the right anterior oblique with the patient supine, so that pressure spot-films of the suspected area can be obtained. Due to the localized spasm, the lumen of the duodenum above the ulcer will remain filled with barium, allowing sufficient time for obtaining adequate spot-films. Any projection, however, that will reveal the duodenum to best advantage should be used.

Despite adequate treatment and a good clinical response, the duodenal deformity may exist for several months. We have never seen obstruction of the lumen due to progressive stenosis. Perforation is a rare complication but has been described (7).

In the differential diagnosis of abnormal changes of this portion of the duodenum one must consider intrinsic disease and changes secondary to biliary or pancreatic lesions. Duodenitis is often diagnosed in cases with irritability and mucosal aberration. It is our feeling that, if a painstaking study is done, most of these cases will disclose an ulcer crater. A fleck of barium in a small diverticulum or in the ampulla of Vater may simulate an ulcer. Duodenal diverticula, if large, offer no difficulty in diagnosis, while smaller diverticula have a smooth contour and mucosa may be seen entering the sac (Fig. 4). This is especially true in cases of uncomplicated diverticula where there is no evidence

of spasm of the adjacent duodenum. Carcinoma of the ampulla of Vater or of the pancreatic head may present difficulty in differential diagnosis if the clinical picture is not clearcut. If the duodenum is narrowed in these cases, the stenosis may be more irregular in appearance and extend over a longer area. The mucosal pattern may show evidence of effacement or actual destruction, although admittedly the mucosal changes incident to inflammatory disease may closely resemble those of malignant infiltration. Widening of the duodenal loop does not necessarily indicate a neoplasm, as it is often seen in inflammatory disease of the pancreatic head. Related examinations, especially intravenous cholangiography, are often of value in these patients (8).

Rarer causes of duodenal deformity found in this region include primary carcinoma, ectopic gastric or pancreatic tissue, and vascular abnormalities. While these conditions may be considered in differential diagnosis, they probably can be ruled out on the basis of the clinical findings and rarity of occurrence.

## CONCLUSION

Postbulbar ulcers occur with greater frequency than one would expect from the published reports and statistics. These ulcers, because of an incidence of bleeding that is almost three times that of ordinary bulb ulcers, and a greater frequency of intractability to treatment, carry a graver prognosis and demand a different therapeutic approach from the usual type of duodenal ulcer. The roentgen picture is characteristic, namely a localized asymmetrical narrowing in the descending duodenum opposite the ulcer crater. A greater awareness of these relatively common lesions should lead to their more frequent diagnosis.

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## SUMMARIO IN INTERLINGUA

### Ulcere Duodenal Postbulbar

Ulceres postbulbar del duodeno occurre plus frequentemente que lo que pote esser expectate super le base del publicate reportos e statisticas. Iste ulceres—a causa de un incidentia de sanguination quasi tres vices plus alte que in ulceres ordinari del bulba e a causa de un alte frequentia de refractorietate al therapia—ha un prognose plus grave e require un methodologia therapeutic differente que le typo usual de ulcere duodenal. Le roentgenogramma es characteristic, exhibiente un localisate restriction asymmetric del duodeno descendente, opposite al crater del ulcere. Si plus attention es prestate a iste relativemente commun lesiones, le resultato va esser un plus alte frequentia de lor diagnose.

# Subcapsular Rupture of the Kidney During Intravenous Urography[1]

MARVIN E. WEINER, M.D., FRANKLIN S. ALCORN, M.D., and EDWARD L. JENKINSON, M.D.

EXTRAVASATION of the contrast medium during the course of retrograde pyelography is not rare. If the material is forcibly injected, thereby raising the intrapelvic pressure above a critical level, any or all of various backflow phenomena may result. In addition to the backflow patterns, actual traumatic rupture of calyx, pelvis, or ureter by the catheter may occur. During intravenous pyelography, on the other hand, extravasation has rarely been described. The phenomenon is not likely in the course of a procedure which is essentially one of physiologic secretion. Certain aspects of the examination as it is usually performed may, however, simulate the conditions of increased intrapelvic pressure, which occurs so frequently in retrograde pyelography.

Hendriock (1) was the first to note pyelorenal reflux in excretory urography. He suggested that this could lead to the spread of infection from pelvis or ureter into the renal parenchyma. No compression was used in his case, but the patient experienced colic and, therefore, quite possibly spasm resulting in increased intrapelvic pressure.

A case of pyelolymphatic backflow during intravenous pyelography was reported by Narath (2), but here again no external compression was used. Thus the author's assumption that intravenous urography is simply a matter of physiologic excretion, while true in 1938, would not necessarily hold today, when external compression is commonly employed.

Following the introduction of external compression as an accepted technic in intravenous pyelography, Coliez (3) classified the types of extravasation which might occur. He referred to Puigvert Gorro's statement that intra pelvic pressure is increased in the presence of an acute ureteral obstruction, calculus, kink, or spasm, and even in certain subacute obstructions. Coliez described an interstitial type of extravasation which, in extreme cases, would invade the cortex and cause subcapsular extravasation on the convex side of the kidney or pass through the renal sinuses to the hilus and then into the subcapsular space. Although the latter situation has been postulated, no actual report has appeared in the literature.

The present case is believed to be the first reported example of subcapsular reflux occurring secondary to rupture of the renal sinuses.

## CASE REPORT

A 48-year-old white woman was admitted to St. Luke's Hospital complaining only of mild gastrointestinal symptoms and hypersensitivity to the common allergens. Physical examination was essentially negative, except for absence of the right breast, which had been removed five years previously for carcinoma.

Intravenous urography was performed as a part of a general work-up. A preliminary film of the abdomen was negative. There was normal visualization of both renal collecting systems five minutes after intravenous administration of contrast material (Fig. 1). Subsequently the patient complained of colicky abdominal pain, and a film made at fifteen minutes (Fig. 2) revealed an unusual collection of contrast material in the right renal pelvis and extending along the capsule, toward both the upper and lower poles. At thirty minutes (Fig. 3) this extension was increased and there was also some dissection of the medium along the upper right ureter. The impression was that rupture of the right upper urinary tract, probably involving the pelvis, had occurred, with extravasation of the contrast material subcapsularly about the kidney and along the upper ureter. A film made six hours after injection (Fig. 4) revealed nearly complete disappearance of the medium from the kidney area. It was believed to have been absorbed and reexcreted. The pain disappeared and no further symptoms appeared. On follow-up, approximately one year later, the patient was asymptomatic.

[1] From the Department of Radiology, St. Luke's Hospital, Chicago, Ill. Accepted for publication in July 1957.

Fig. 1. Five minutes after intravenous administration of contrast medium. Good visualization without extravasation.

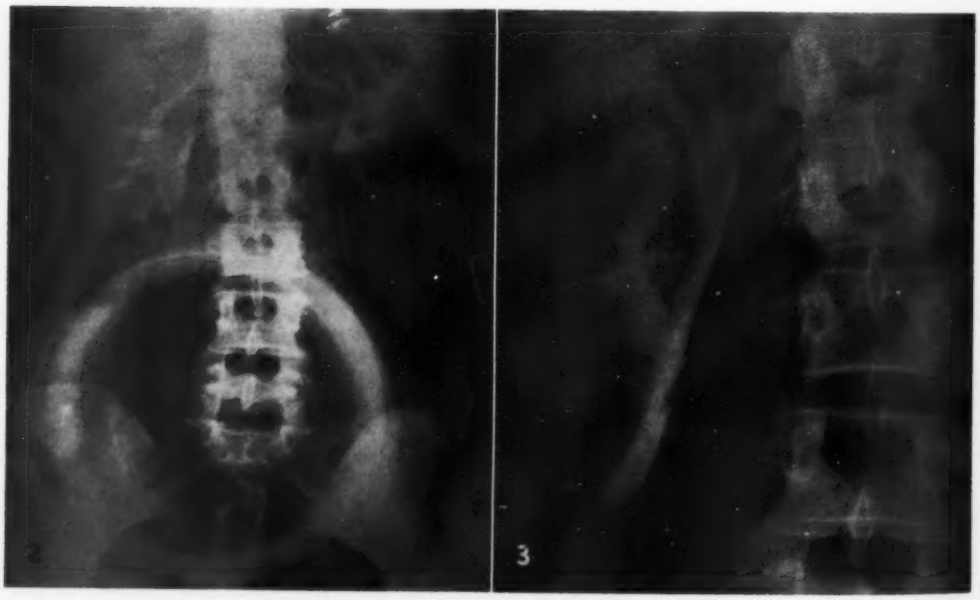


Fig. 2. Fifteen minutes after injection of contrast medium, showing early subcapsular extravasation.
Fig. 3. Detail of right kidney at thirty minutes, showing subcapsular collection of medium with extension along upper ureter, probably in subserosa.

*Comment:* The pneumatic compressor used in this case was so placed that the lower margin of the rubber balloon was about 2 inches above the symphysis. The balloon is 6 inches in diameter. It is usually inflated to a pressure of between 60 and 80 mm. Hg, with an average compression of 70 mm. The patient was thin, and the pressure could not have exceeded 70 mm.


## SUMMARY

A case of subcapsular rupture of the right kidney during excretory urography is presented. It is apparent that the use of external compression may cause sufficient retrograde pressure to produce rupture of the collecting system near its origin and permit subcapsular extravasation of the contrast medium. The authors believe that this is the first case of its type reported. The patient suffered no ill effects.


St. Luke's Hospital
Chicago 5, Ill.

Fig. 4. Six-hour film showing absorption of most of the contrast material from the subcapsular area.

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## SUMMARIO IN INTERLINGUA

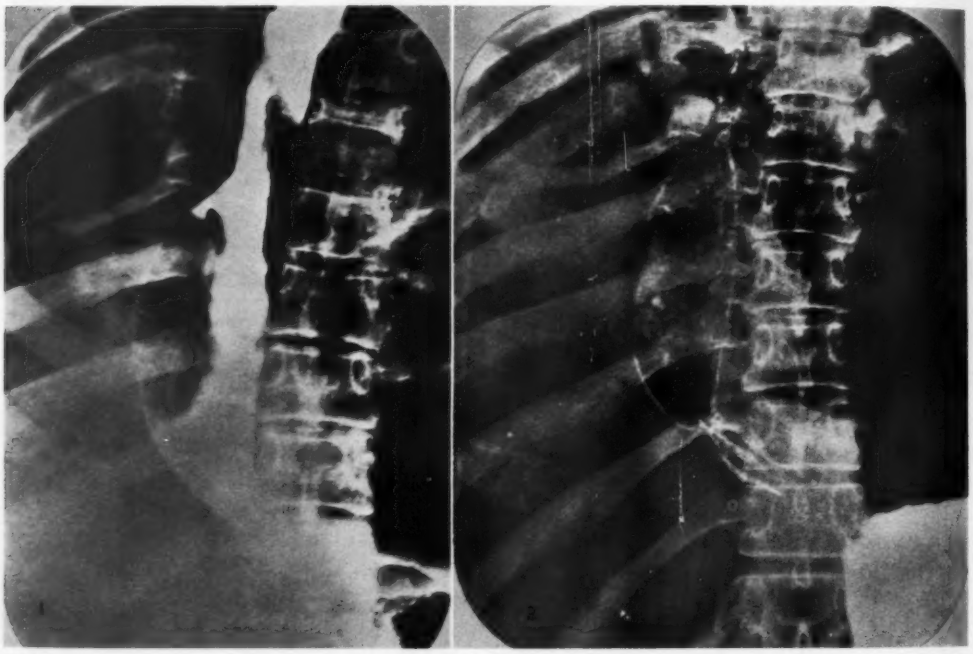
### Ruptura Subcapsular Del Ren In Urographia Intravenose

Es presentate un caso de ruptura subcapsular del ren dextere, occurrente durante urographia excretori. Il es apparente que le uso de compression externe pote effectuar un grado sufficiente de pression retrograde pro producer un ruptura del systema de collection presso a su origine e permitter le extravasation subcapsular del substantia de contrasto. Le autores crede que isto es le prime caso de su genere que ha unquam essite reportate. Le patiente suffreva nulle effectos adverse.

# The "Gastric-Lined" Esophagus with Esophagitis[1]

MAX L. SOM, M.D., F.A.C.S.,[2] JEROME H. SHAPIRO, M.D.,[3] and
HAROLD G. JACOBSON, M.D., F.A.C.R.[4]

In 1950, Barrett (1) pointed out that in some cases of esophageal peptic ulcer the lower portion of the esophagus may have a gastric lining. He found that the distal esophagus was occasionally lined for a variable extent by glandular or atrophic gastric epithelium. For this congenital anomaly Allison and Johnstone (2) suggested the designation "gastric-lined esophagus." Except for the atypical lining, the gross structural characteristics are similar to those of the normal esophagus. In contrast to isolated discrete islands of ectopic gastric mucosa sometimes observed in the esophagus, the gastric epithelium in these cases is heterotopic, occurring in a continuous sheet. The roentgen features are characteristic and are illustrated by the following case.



Figs. 1 and 2. Esophagograms. The esophagus is deviated to the right, secondary to the right pneumonectomy. A "double-sac" contour is present, with the dilated segments of the esophagus separated by zones of narrowing in the upper and lower portions. A small hiatal herniation is present.

A 42-year-old Puerto Rican female was admitted to Montefiore Hospital on July 31, 1956, complaining of cough and chest pain. She had had no chills,

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[4] Chief, Division of Diagnostic Radiology, Montefiore Hospital; Clinical Professor of Radiology, New York University College of Medicine.

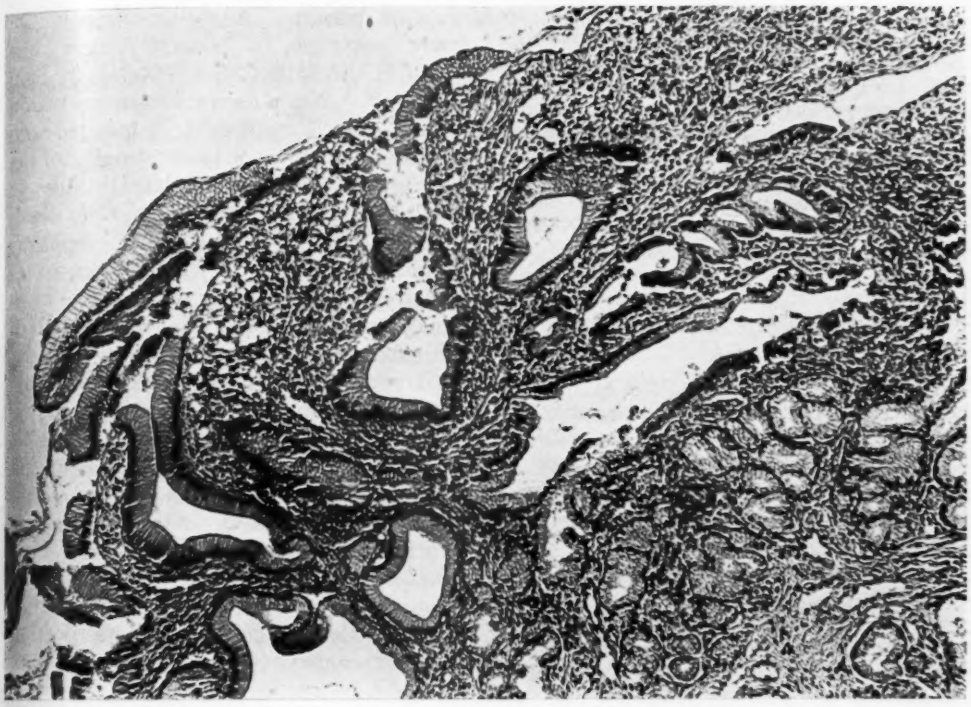

Fig. 3. Photomicrograph of biopsy specimen of esophagus at 30 cm. from the upper incisor teeth (just below upper zone of narrowing shown in Figs. 1 and 2). Numerous mucus-producing glands are present in the mucosa. These glands are ordinarily seen in the cardiac portion of the stomach. A considerable accumulation of chronic inflammatory cells is present in the mucosa and submucosa. Hematoxylin and eosin. ×85.

fever, night sweats, or hemoptysis. There were no complaints referable to the gastrointestinal tract. In January 1956, she had undergone a right pneumonectomy for cavitary tuberculosis.

The only positive pertinent physical findings were referable to the right chest, which showed the usual stigmata of a past pneumonectomy.

In August 1956, the patient was placed on chemotherapy for cavitary tuberculosis of the left upper lobe. In December 1956 she began to complain of substernal heaviness, with inability to eat normal amounts of food without discomfort. There was no vomiting.

Roentgen examination of the esophagus with barium on Dec. 3, showed a "double sac" contour of the lower two-thirds, with two zones of narrowing, one at the junction of the upper and middle thirds and one in the lower third (Figs. 1 and 2). Between these narrowed segments, the esophagus was seen to be moderately dilated. The usual esophageal mucosal pattern was not observed in this area. A small esophageal hiatus hernia was also seen.

The first of two esophagoscopic examinations was then performed, showing the esophagus to be displaced to the right. It was somewhat narrowed in its upper portion but still admitted a 12-mm. esophagoscopic tube. At 33 cm. from the upper incisor teeth, the lumen abruptly widened to a considerable extent. Distal to this area of widening, the mucosa of the left lateral wall appeared reddened and granular. This inflammatory mucosal pattern continued for about 4 to 5 cm., when a zone of narrowing and spasm appeared. The esophagoscope was passed beyond the stenosis with considerable difficulty. At 38 cm., reflux gastric juice appeared and normal gastric rugae were recognized. A mucosal biopsy was taken just proximal to the narrowed segment, at a distance of 37 cm. from the upper incisors. The pathologic (microscopic) report of this biopsy follows[5]:

*Microscopically* the specimen was found to contain irregular fragments of gastric mucosa. These included fairly regular mucous glands which were invested by uniform goblet cells. The intervening stroma was edematous and moderately heavily infiltrated with plasma cells and lymphocytes. Nowhere was there evidence of malignant change, and no tissue could be identified as esophageal tissue. *Diagnosis:* Gastric mucosa, which appears inflamed.

[5] The slides were reviewed by Dr. Jack Hasson, Division of Pathology. We are grateful for his help.

After re-evaluating the roentgenograms of the barium-filled esophagus, taking into consideration the first esophagoscopic procedure, a diagnosis of gastric-lined esophagus with esophagitis was entertained by one of us (M. L. S.) on the basis of a case previously observed (3). On a repeat esophagoscopy undertaken to confirm this diagnosis, the altered gastric mucosa lining the distal esophagus could not be differentiated grossly from the inflammatory squamous mucosa encountered in peptic esophagitis. Biopsy specimens were obtained from the upper third of the esophagus at 30 cm., just below the proximal zone of esophageal narrowing at 34 cm., and just below the distal zone of narrowing at 40 cm. The pathologic (microscopic) report follows:

*Microscopic* examination of the first specimen (30 cm.) showed a layer of stratified squamous epithelium lining one surface. This was intact and somewhat acanthotic, but otherwise unremarkable. In the underlying submucosal connective tissue was a moderate infiltration of chronic inflammatory cells. The second specimen (34 cm.) was lined on one surface by a layer of columnar epithelium. In the mucosa were numerous mucus-producing cells of glandular form, similar to those seen at the cardiogastric junction. Both mucosa and submucosa showed a moderately severe infiltration of chronic inflammatory cells. The third portion of the specimen (40 cm.) was also lined by a layer of mucosa containing numerous glandular elements, compatible with those found in the stomach. The mucosa and submucosa were again infiltrated with chronic inflammatory cells. In none of the specimens was there evidence of atypical or malignant change. *Diagnosis:* Chronic esophagitis and gastritis.

The second esophagoscopic examination, together with the roentgen examination of the barium-filled esophagus and the microscopic studies of the biopsy specimens conclusively proved the presence of a gastric-lined esophagus.

## DISCUSSION

Som and Wolf (3) have emphasized, in reporting a similar case, that the characteristic finding, demonstrable roentgenographically with a barium swallow, in a gastric-lined esophagus is a "double-sac" appearance with a zone of narrowing above and below the distended area in the lower half of the esophagus. The upper area of narrowing corresponds to the junction of esophageal squamous epithelium with heterotopic gastric epithelium; the lower zone of narrowing to the junction of the esophagus with the stomach. A sliding hernia may be present. A peptic ulcer in the lower esophagus (a "Barrett" ulcer) was noted in the earlier case reported by Som and Wolf. When ulceration occurs within a gastric-lined esophagus, it may be seen at either the upper or lower margins of the segment. When an esophageal ulcer is seen to be quite deep and higher than usual, the possibility of a gastric-lined esophagus should be suspected. In the case reported here, no ulcer was seen, but inflammatory changes at the lower margin of the tubular sac, as well as in the gastric-lined area, were found. The altered gastric mucosa in the distal esophagus is apparently just as susceptible to peptic digestion as is the squamous esophageal mucosa. Generally, the most pronounced inflammatory changes and superficial ulceration will occur proximal to the juncture of the gastric-lined esophagus and stomach. Should the esophagitis continue, peptic changes in the distal portion of the squamous esophageal mucosa will, no doubt, be manifest.

The roentgen appearance is pathognomonic, but the recognition of this condition may not be readily apparent on either esophagoscopy or gross examination of the esophagus. Actual microscopic sections from serial biopsies at graduated levels are necessary for a definitive diagnosis.

## SUMMARY AND CONCLUSIONS

A case report of "gastric-lined" esophagus is presented, in which the diagnosis was suggested by roentgen examination after a barium swallow and finally confirmed by esophagoscopy with serial biopsy studies at graduated levels. Evidence of inflammatory changes indicating esophagitis was found in specimens from all three zones examined. The roentgen findings of the gastric-lined esophagus are considered characteristic and when seen should enable the alert radiologist to suggest the presence of this entity. Peptic ulcer and/or chronic inflammatory esophagitis may occur at the superior and inferior margins of the gastric-lined region.

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SUMMARIO IN INTERLINGUA

**Esophago A Revestimento Gastric Con Esophagitis**

Es reportate un caso de esophago a "revestimento gastric," in que le diagnose esseva suggerite per le roentgeno-examine post ingestion de barium. Le confirmation del diagnose esseva finalmente obtenite per esophagoscopia, con studios de biopsia serial a tres differente nivellos del esophago. Le specimens bioptic ab omne le tres zonas monstrava alterationes inflammatori que indicava esophagitis.

Le constatationes roentgenologic es considerate como characteristic e deberea permitter al radiologo qui es alerte suspicer le presentia de iste entitate. Le aspecto le plus eminente es le apparentia a "sacco duple" in le esophago inferior, con un zona de restriction supra e infra le area de distension. Le zona superior de restriction corresponde al junction de epithelio squamose esophagee con heterotopic epithelio gastric. Le zona inferior de restriction corresponde al junction del esophago con le stomacho.

Ulcere peptic o esophagitis chronic pote occurrer al margines del areas a revestimento gastric.

# Trichobezoar

## With a Case Report[1]

ANDREW R. McGEE, M.D., and ROSS LOBB, M.D

BEZOARS ARE defined as certain concretions or masses of foreign material found infrequently in the stomach and intestines of man and animals. Phytobezoars consist mainly of unabsorbed fruit or vegetable residues, while trichobezoars contain hair as a principal component.

From early medical records it is obvious that a multiplicity of mythical curative powers were accredited to these strange bodies. In their magnificent review (1938), DeBakey and Ochsner (2) allude to the Hindu knowledge of bezoars in the 12th century B.C. and to the reverence extended them even into the 18th century A.D. In addition to more fanciful attributes, they were regarded as an antidote for poison and a restorative of sexual potency. These powers, however, were reserved for the phytobezoar. The trichobezoar was awarded no such honor. It has been inferred that this was due to its extreme foulness, but, in view of the forbidding character of other alleged healing substances of the past, this seems unlikely. Be that as it may, we shall limit ourselves here to the simple consideration of the hair ball as an interesting medical problem.

The rarity of trichobezoars is emphasized by a search of the literature. Including 1 case of their own, DeBakey and Ochsner found a total of but 172 reported examples. Since their comprehensive review, in 1938, there have been occasional additions to this number. Peake, in 1948, cited 11 cases appearing in the interval and added still another. Further single cases were reported by Nelson and Colvin (6), Smoller, Schreiber and Scott (8), Fox and Stiles (4), and Chaudhuri (1). The latter estimated the 1951 total at 202. In 1956 he published the interesting case of a child who, following removal of a bezoar in 1953, resumed trichophagia, so that a second hairball was taken from the stomach in 1955.

The classical article of Rudolph Matas (5), in which he described the groping for diagnosis in the early roentgen era is well known. His assumption that the more frequent occurrence of trichobezoar in females is attributable to their longer hair and the consequent ease of getting it into the mouth is still credible.

Habit pattern, personality maladjustment, mental instability, and tension have been considered as causative factors in trichophagia. With steady improvement of x-ray technics, identification of bezoars in the stomach has become simplified. Symptoms are somewhat dependent on the size of the mass and the duration of the habit of hair eating. Various degrees of secondary anemia are frequently observed, and less often there are gastric ulceration and hemorrhage. If the hair ball is small, it may pass into and lodge in the small bowel, producing the clinical picture of obstruction.

The specimen may vary from an average (wet) weight of approximately 1.6 pounds to the extreme of 6.5 pounds reported by Davies (3). It is dark greenish black in color, of firm consistency, composed of semisolid material interlaced with hair, and emitting a foul odor. The larger trichobezoars assume the shape of the stomach, with at times a projection into the duodenum.

Treatment is surgical removal by gastrotomy. If passage into the small bowel has occurred ileotomy may be done or the mass may be expressed into the colon.

### CASE HISTORY

A 23-year-old self-assessed happy housewife, of high intelligence, exhibited a lump in the abdomen which had first come to her attention when she was kicked by a baby. She volunteered that, when excited, she pulled hair from her head and ate it.

[1] Accepted for publication in July 1957.

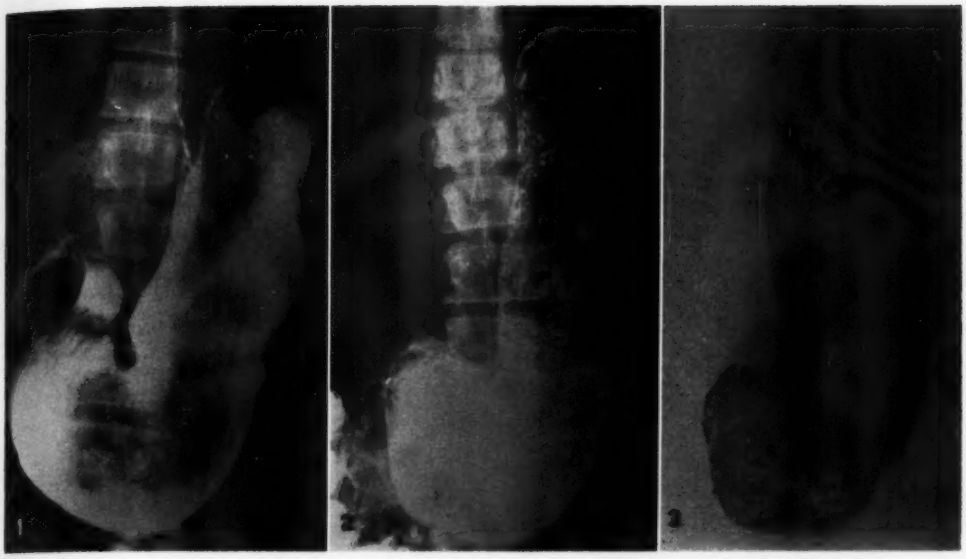

Fig. 1. Roentgenogram showing the large trichobezoar as a negative shadow against the opaque medium.
Fig. 2. Six-hour film.
Fig. 3. Operative specimen. The mass measured 22 × 5 cm. and weighed 380 gm.

This peculiarity was unknown to her husband to whom she had been married for five years. For several years she had subsisted on fifteen or twenty small meals a day.

The patient appeared to be somewhat undernourished, and a large hard mass was palpable in the epigastrium. Laboratory findings revealed a moderate degree of secondary anemia.

Under the fluoroscope it was observed that a large object practically filled the stomach cavity as outlined by the barium mixture. A roentgenogram (Fig. 1) showed a negative shadow created by the bezoar in the opaque medium. A six-hour film portrayed the foreign mass with residual barium coating (Fig. 2), giving a fair indication of how nearly completely it filled the stomach.

A gastrotomy was performed, and a hook-shaped mass, 22 × 5 cm., composed of hair and food residues and weighing 380 gm. (semi-dry), was removed. Recovery was uneventful and the patient returned to regular eating habits and gained weight. However, her good intentions, and preoperative promises were not sustained, and two years later she admitted to again eating her hair. Shortly thereafter, she moved to another part of the country and her subsequent history has not been obtainable.

## SUMMARY

A case of trichobezoar has been reported, bringing the world total as of this date to 205 or more. The patient's early resumption of trichophagia after operation emphasizes the great difficulty in breaking that habit.

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(*Pro le summario in interlingua, vider le pagina sequente*)

SUMMARIO IN INTERLINGUA

## Trichobezoar, Con Le Reporto De Un Caso

Es passate in revista le litteratura in re trichobezoares, con un total de circa 205 casos. Es reportate un exemplo in un femina de vinti-tres annos de etate, qui admitteva inglutir capillos sub stress emotional. Le examine roentgenologic monstrava un grande umbra negative contra le medio opac in le stomacho. Isto indicava le presentia de un grande bezoar. Gastrotomia esseva executate, e un massa componite predominantemente de capillos, de un largor de 22 × 5 cm e un peso de 380 g (in stato semi-sic), esseva removite. Le patiente subsequentemente recomenciava su habitude de inglutir capillos, sed su historia consecutori non es cognoscite.

# Spondylolysis and Spondylolisthesis

## Case Report Clarifying the Etiology of Spondylolysis[1]

CHESTER C. SCHNEIDER, M.D., and ABRAHAM MELAMED, M.D.

IT IS GENERALLY believed that spondylolysis or spondylolisthesis does not occur at birth, and no such case has been reported in the literature. There is, however, no example of the disease on record in which roentgenograms have been available both before and after development of the spinal changes. It is the purpose of this paper to present a case with roentgenograms of the spine before and following the occurrence of idiopathic spondylolysis with progressive spondylolisthesis.

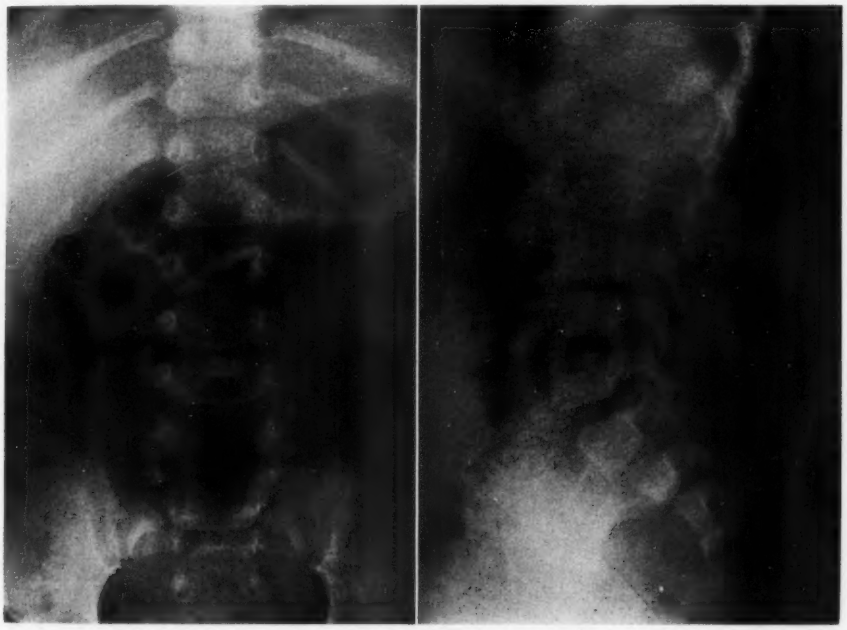

Fig. 1. Age one year six months. No spondylolysis present. The intervertebral disk at L-3 is narrowed and the adjacent vertebral body margins are slightly irregular.

### CASE REPORT

This male patient was born June 14, 1936, following a normal delivery. At the age of four and a half months he was hospitalized for whooping cough. When about a year old, he fell down a flight of stairs. There was, however, no evidence of any post-traumatic reaction in the lower back at the time, and no x-ray studies were made. Some six months later he experienced stiffness of the lower back but roentgenograms of the spine (December 1937) disclosed no evidence of spondylolysis or displacement, though abnormalities were observed at the L-3–L-4 junction. The intervertebral space was narrowed and the adjacent vertebral body surfaces were slightly irregular (Fig. 1). Anteroposterior and lateral views disclosed no defects or clefts in the interarticular portions of the vertebrae. A diagnosis of infection of the 3d lumbar disk or chondritis of indeterminate etiology was made and protective treatment was provided until complete subsidence of the pathological process had occurred.

[1] From the Departments of Orthopedic Surgery and Radiology, Evangelical Deaconess Hospital, Milwaukee, Wis. Accepted for publication in July 1957.

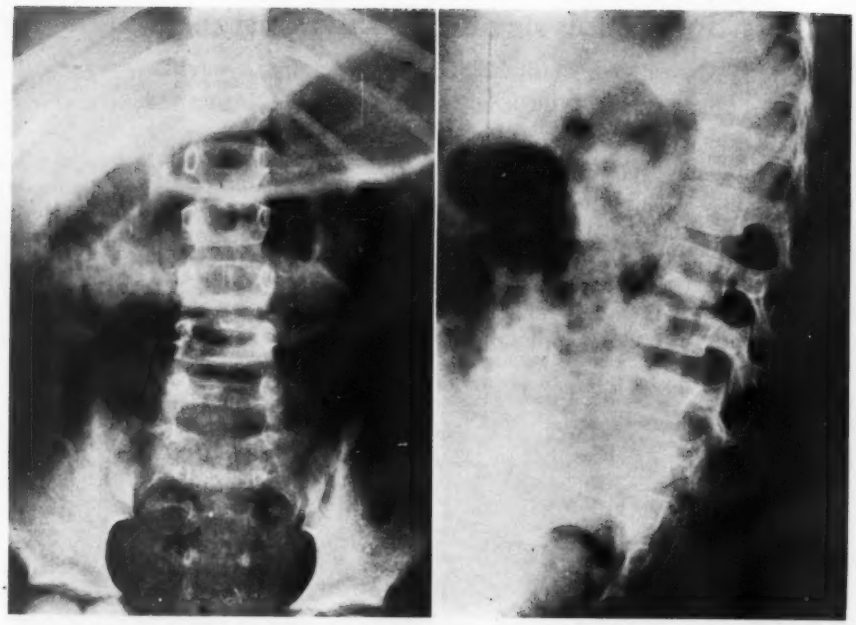

Fig. 2. Age five years four months. No essential change as compared to Fig. 1.

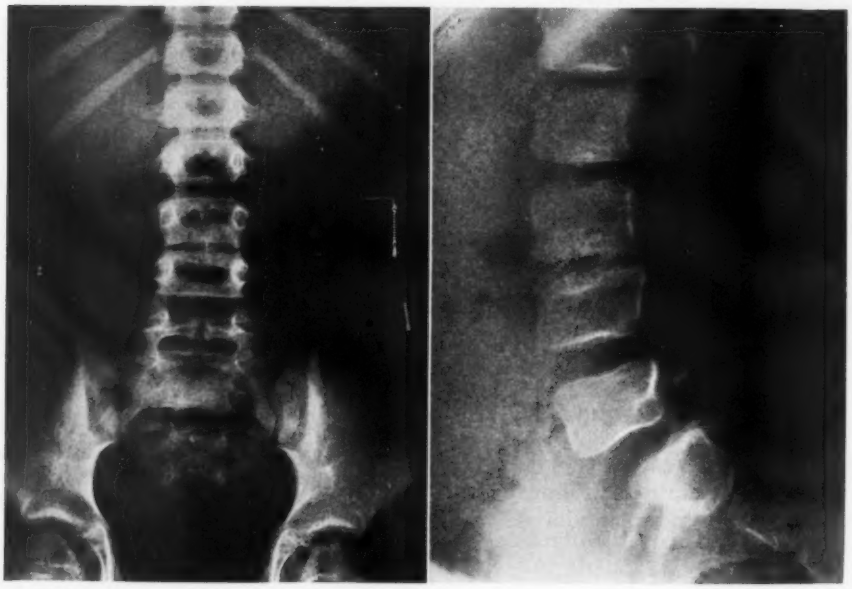

Fig. 3. Age eight years six months. Spondylolysis and listhesis at lumbosacral junction visible for first time. Arrow indicates lytic zone or gap.

Follow-up radiographic studies obtained in October 1941, at the age of five years four months, showed no essential change in the appearance of the spine (Fig. 2) since the first examination about four years earlier. In December 1944 (age eight years six months), anteroposterior and lateral roentgenograms showed spondylolisthesis at the lumbosacral junction (Fig. 3). The 3d lumbar intervertebral space appeared thinner in proportion to the size of the vertebral bodies and in comparison with the other lumbar disks. Growth of the intervertebral disk was evidently aborted several years earlier by the pathological process involving it. Oblique views of the lumbar spine were not obtained.

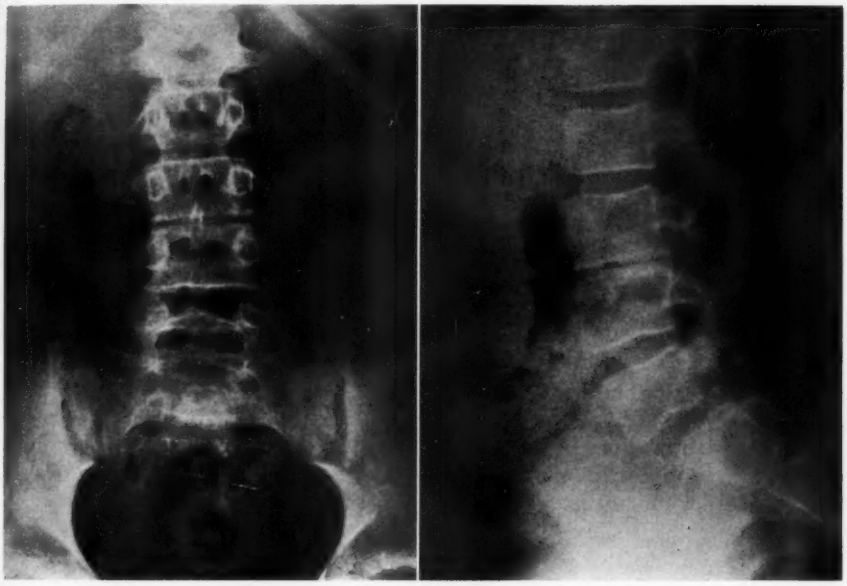

Fig. 4. Age fifteen years three months. Progression of spondylolisthesis during seven years. The disk at L-3 is almost completely obliterated.

Anteroposterior, lateral, and oblique views of the spine in September 1951 (age fifteen years three months) showed increased forward displacement of L-5 on the sacrum, wider gaps in the interarticular septa, thinning of the disk at L-5, excavation in the posterior articular surface of the sacrum, and increased lumbosacral angulation (Fig. 4). The 3d lumbar intervertebral disk was almost obliterated.

The patient submitted to spinal fusion a few years later. His spinal architecture has remained static since the performance of fusion and he has continued in good health.

## COMMENT

A voluminous literature exists on the subject of spondylolisthesis, particularly with regard to etiology. Theories based on congenital, developmental, and/or traumatic factors have been advanced, but there has heretofore been no documentary proof of any of these. It is fairly well agreed, however, that spondylolysis or spondylolisthesis is not found at birth. Therefore, postnatal and other etiologic factors must be responsible for this disease.

Caffey (1), Wigby (2), and others advance the theory that a congenital defect or narrowing of the isthmi exists in early infancy and constitutes a weakened area prone to injury or breaking during normal childhood. No observer has demonstrated progressive narrowing of the interarticular portions prior to the development of lysis or listhesis. Neither in the case presented nor in our other experience have we been able to detect any such bony structural "weakness" by radiographic examination in infancy.

From the evidence at hand we feel justified in proposing that the bony defects of spondylolysis are the direct result of

trauma to structurally inadequate isthmi, usually within the first two decades of life. The significance of the supporting soft-tissue structures and associated anomalies of the spine in such patients is not known precisely, but these elements are undoubtedly important in an overall consideration of the subject.

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SUMMARIO IN INTERLINGUA

**Spondylolyse E Spondylolisthese: Reporto De Un Caso, In Clarification Del Etiologia De Spondylolyse**

Le autores reporta le caso de un juvene homine con spondylolisthese al junction lumbosacral, primo demonstrate al etate de octo annos e quatro menses. Le prime roentgenogrammas del columna vertebral esseva obtenite al etate de un anno e medie, circa sex menses post un cadita. Iste roentgenogrammas revelava nulle signos de spondylolyse o displaciamento, ben que le spatio intervertebral inter L-3 e L-4 esseva restringite e le adjacente margines del corpore vertebral levemente irregular. Iste apparentia non esseva alterate quatro annos plus tarde; sed ancora tres annos plus tarde, spondylolyse e spondylolisthese esseva primo observate. Le spondylolisthese esseva progressive, e al etate de dece-cinque annos le disco a L-3 esseva quasi completemente oblitterate.

Le concepto es proponite que le defectos ossee de spondylolyse es le resultato directe de trauma in structuralmente inadequate isthmos, usualmente intra le prime decennios del vita.

# An Experimental Determination of Energy Absorbed in Water from an X-Ray Beam[1]

GAIL D. ADAMS, Ph.D.

EVER SINCE the adoption by the International Commission on Radiological Units of the *rad* as the unit of absorbed dose (16) there has existed the problem of measurement of this quantity. A few reports (2, 6, 8) have appeared of measurements of local energy absorption with microcalorimeters, but in media different from water. The method most widely used to determine absorbed doses involves observation of ionization currents in a suitable cavity chamber with subsequent interpretation by means of the Bragg-Gray principle. This principle employs a product, $WS$, as proportionality factor between the observed ionization and requisite absorbed dose. $W$, the energy required to produce one ion pair in the cavity atmosphere, is capable of direct measurement (7). $S$, the stopping power of the condensed phase outside the cavity relative to the cavity atmosphere, can be calculated, in this case including the density correction by Sternheimer (18).

This paper presents a method for determining absorbed dose in water without formal use of the Bragg-Gray relation and records an application of the method to x-rays from a 70-MEV synchrotron. It is hoped that adequate refinement can be achieved by such methods as this to validate the computational method of determining absorbed dose with $WS$. No error is suggested in present methods; rather, an independent check is sought.

The method presented employs a calorimeter to measure the energy content of a given beam of x-rays and also the transmission of that beam through a water phantom. The energy absorbed in the water bath must be the difference between the two calorimetric measurements, reduced by a small amount to include leakage radiation outside the useful beam. A small ionization chamber is used to explore systematically the region of the phantom in and near the beam; ionization at substantial distances from the beam is read on a larger chamber. Recognizing that local energy absorption should be proportional to local ionization (with allowance for change in proportionality outside the beam), a numerical integral can be formed in terms of arbitrary units, such as (grams of water) × (per cent of peak ionization), which must be proportional to the total energy absorbed in the phantom. Dividing the energy absorption result from the calorimeter runs (expressed in ergs absorbed per monitor unit) by the numerical integral gives directly the local energy absorption at the peak of the depth-dose curve in rads per monitor unit. The monitor unit of exposure can be used to relate this to any other desired measurement.

## THE CALORIMETER

The calorimeter used is basically of conventional design (10, 11, 14). Twin 10-cm. lead cubes are suspended on nylon line in an evacuable brass box. The surfaces of the cubes and the inside of the box are silver-plated to minimize energy transfer by radiation. Additionally, a polished aluminum plate has been suspended between the cubes. The absorbers were formed as cubes so that either horizontal or vertical x-ray beams could be used. The snouts on the box which serve as x-ray entrance portals are sealed with 0.003-in. aluminum sheet, polished inside. A small amount of Teflon for electrical insulation and the neoprene vacuum gasket are the only nonmetallic or nonvitreous materials

[1] From the Radiological Laboratory, Department of Radiology, University of California School of Medicine, San Francisco, California. The Radiological Laboratory is one of the research and development installations of the U. S. Atomic Energy Commission. Presented at the Forty-Second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1956.

exposed to the evacuable volume. Vacua of the order of $10^{-6}$ mm. Hg are achieved, thus minimizing energy transfer by gas molecules. Four thermistors and two electric heaters are imbedded with Wood's metal in each cube. The electrical connections to these are of sufficiently thin wire to render negligible the energy transfer by conduction. General temperature control is maintained in an oil bath in which the brass box is submerged.

A temperature change in one cube resulting from energy absorption in that cube is observed with a high sensitivity galvanometer used as a null detector while balance on a Wheatstone bridge is maintained. The arms of the bridge are each thermistors (WE 14A or VECO 51A1) with opposing arms being thermistors located (Fig. 1) in a single cube. Two complete bridges are incorporated, the second serving as a spare.

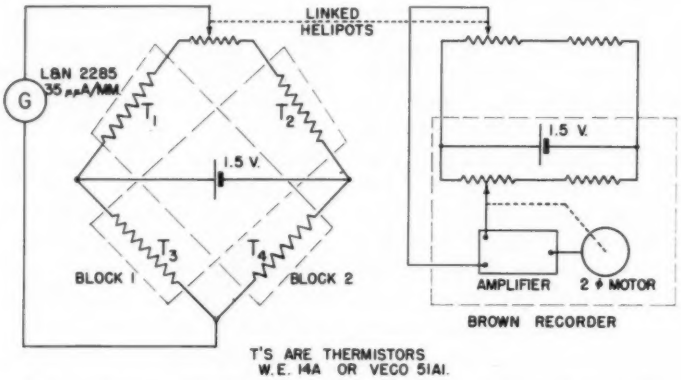


Fig. 1. Calorimeter circuit, including mechanical linkage which enables continuous recording to be made of the null balance which is maintained by watching galvanometer (G) and operating balance helipot.

The thermistors used have a room temperature resistance of about 100 K ohms and a negative coefficient of resistance in the neighborhood of 4.7 per cent per degree centigrade. This coefficient varies appreciably among thermistors and is a slow function of temperature. From a group of thermistors it is easy to select a set of four for the bridge which will enable a balance to be reached without addition of a substantial series resistor in any leg. Realizing, however, that the temperature of both cubes would be slowly increased during a series of runs, it seemed important to seek a thermistor selection which would remain essentially balanced when the temperature of both cubes changed an equal amount. Denoting by $T_i$ the resistance of the $i$th thermistor at a given temperature, the change in resistance for a small temperature change $\Delta\theta$ has been written

$$\Delta T_i = T_i(a_i\Delta\theta + b_i\overline{\Delta\theta}^2) \qquad (1)$$

Substituting Equation 1 in the general relation for bridge balance, the galvanometer current can be expressed as a series of terms in ascending order of $\Delta\theta$. The numerator of the term not depending on $\Delta\theta$ is the ordinary bridge balance relation. The numerator of the coefficient of $\Delta\theta$ can be written

$$(R_1 + T_1)[a_2T_2(R_2 + T_2)^{-1} + a_3 - a_1 - a_1] + a_1R_1 \qquad (2)$$

With some diligence in selection of thermistors, it is possible to have Equation 2 vanish simultaneously with the bridge balance relation. In Equation 2, $R_1$ is that part of the variable balancing resistance which is in series with $T_1$, and $R_2$ that part in series with $T_2$. Before introducing this criterion, it seemed important to control the oil bath temperature to $\pm 0.01^\circ$ C.,

whereas now a 1° C. change is scarcely detectable.

Use of the calorimeter involves irradiation of one cube for a time (3 to 8 minutes) necessary to change the temperature of that cube approximately $1.5 \times 10^{-3}$° C. Since this change unbalances the temperature equilibrium previously obtained, the next temperature change will be made in the other cube electrically by means of the resistance wire heaters in that cube. The heater power is adjusted to match approximately the x-ray power. Preceding the first irradiation and between each heating interval, the null balance is watched carefully to follow the slow drift which is seen. As shown in Figure 1, a mechanical linkage has been arranged between the bridge balance resistor and a recording potentiometer to produce a permanent record of the balance condition. A day's run normally consists of eight irradiations, eight calibration heatings, and seventeen periods of drift observation. A change in conditions would then be made, for example, to irradiate the other cube or to use a different beam size.

For analysis of thermistor resistance as a function of time, Newton's law of cooling is assumed to hold and the thermistor resistances ($T_i$) are considered to be sufficient indicators of temperature for the small changes involved. In an exaggerated way, Figure 2 illustrates the resistance behavior of a thermistor with time before, during, and after a typical heating cycle. The ($T_i$, $t_i$) here represent the thermistor resistance and corresponding time for each point. $T_e$ represents the equilibrium resistance corresponding to the existing temperature of the surroundings and is assumed constant during the run. Newton's law is written

$$\dot{T} = \partial T/\partial t = -k(T - T_e) \qquad (3)$$

so that, starting from any ($T_i$, $t_i$),

$$T(t) = T_e + (T_i - T_e) \exp\,[-k(t - t_i)] \qquad (4)$$

For the case of uniform heating during $t_2 \leq t \leq t_3$, a constant additive term, $\dot{T}_x$, must be introduced into Equation 3:

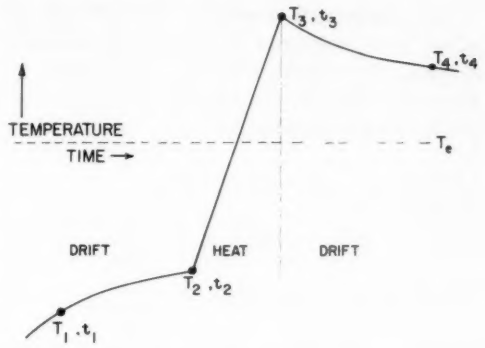


Fig. 2. Exaggerated characteristic heating response obtained with the calorimeter by maintaining bridge balance.

$$\dot{T} = \dot{T}_x - k(T - T_e) \qquad (5)$$

whence

$$\dot{T}_x = k\,\frac{T_3 - T_e - (T_2 - T_e) \exp\,[-k(t_3 - t_2)]}{1 - \exp\,[-k(t_3 - t_2)]} \qquad (6)$$

Integrating over time between $t_2$ and $t_3$, the whole change is

$$\Delta T_x = \frac{k(t_3 - t_2)}{1 - \exp\,[-k(t_3 - t_2)]} \{T_3 - T_e - (T_2 - T_e) \exp\,[-k(t_3 - t_2)]\} \qquad (7)$$

Equation 7 represents the total resistance change of a thermistor during the heating cycle and therefore also the pattern of the bridge balance record. Recognizing that $k(t_3 - t_2) = k\,\Delta\,t \ll 1$, an expansion of Equation 7 is made in powers of $\Delta t$:

$$\Delta T_x = (T_3 - T_2) + k\Delta t\left(\frac{T_3 + T_2}{2} - T_e\right) + k^2\overline{\Delta t}^2\left(\frac{T_3 - T_2}{12}\right) + \ldots \qquad (8)$$

The first two terms of Equation 8 are identical with those in Laughlin's Equation 20 (12); the third term arises from non-linearity of drift rate between heating runs and is ordinarily quite negligible. Thus, the graphical construction required to determine $\Delta T_x$ is extension of the pre- and post-heating drift rates to the midtime of the heating period. The distance between these extended lines at that time represents $\Delta T_x$.

The coefficient $k$ can be evaluated from other measurements on the bridge balance record. For this analysis, one refers to Figure 2 and chooses $t_2 - t_1 = t_4 - t_3$. Then from Equation 4,

$$\frac{T_2 - T_e}{T_1 - T_e} = \exp\left[-k(t_2 - t_1)\right] = \exp\left[-k(t_4 - t_3)\right] = \frac{T_4 - T_e}{T_3 - T_e} \quad (9)$$

Eliminating $T_e$, we solve for $k$:

$$k = \frac{1}{t_2 - t_1} \ln \frac{T_1 - T_3}{T_2 - T_4} \quad (10)$$

Determining $k$ by applying Equation 10 to many records gives a spread of values between 0.2 and $1.0 \times 10^{-5}$ sec.$^{-1}$. This is interpreted to indicate a mean heat transfer time constant between cubes and surrounding environment of approximately three days. A direct computation of $k$ from rates of energy transfer for the conditions in use leads to a value of $0.15 \times 10^{-5}$ sec.$^{-1}$. Fluctuating pressure in the evacuated space and somewhat tarnished silver surfaces are thought to be responsible for the discrepancy. With a good vacuum, surface reflectivity provides the lower limit of energy transfer rate.

The sensitivity of the bridge detection circuit is worthy of comment. The galvanometer, L & N 2285-f, has a nominal sensitivity of 35 $\mu\mu a$/mm. but, by careful balancing, this has been increased to 11 $\mu\mu a$/mm. Since the coil resistance is about 800 Ω, the voltage response will be about $10^{-8}$ volts/mm. To minimize thermal emf problems, all conductors except the balancing resistor, the galvanometer suspension, and the thermistors are copper only, and all junctions are clamped mechanically and then soldered with L & N 107-1-0-1 "thermal-free" solder. The galvanometer and the balancing resistor are each placed in enclosures which incorporate electrostatic and thermal shields. At apparent balance, a fluctuation of about ±0.1 mm. remains. Since 2.5-mm. galvanometer deflection corresponds to one division on the strip chart and most runs were gauged to 90 division deflections, the maximum uncertainty from this source is 0.04 per cent. The potentiometer dead zone is 0.06 per cent of full scale or 0.07 per cent of deflection.

The division calibration on the strip chart depends on the temperature of the thermistors; all values found for the temperature range used were close to 0.0210 joules per division. Since the heat capacity of the cubes is 308 calories per degree centigrade, full-scale deflection implies a temperature change in one cube of $1.63 \times 10^{-3}$ °C., and 1 mm. galvanometer deflection implies a temperature change of $6 \times 10^{-6}$ °C.

Since the thermistor bridge is continuously in operation, the thermistors are slow y heating both cubes and in general not at the same rate. The ratio of the difference in power between the two cubes to the power in one of them can be reduced to

$$\frac{\Delta P}{P} = \frac{T_1 + T_4 - T_2 - T_3}{T_3 + T_4} \quad (11)$$

which amounts to 1.0 per cent for the bridge used. The difference in power is effective in producing spurious bridge unbalance. With bridge power supplied from a 7.5-volt battery and taking the mean thermistor resistance at 80 KΩ, the power continuously supplied to the cubes from this source is $3.5 \times 10^{-4}$ watts. During a days run of typicall y $2.4 \times 10^4$ sec., the temperature of a cube would be changed $6.7 \times 10^{-3}$ °C. from this source, and the difference between cubes would be $7 \times 10^{-5}$ °C This corresponds to a line shift on the chart of 4.5 divisions or about 0.1 division during each heating run. Since the extrapolation uncertainty on the strip-chart record appears at most to be 0.2 divisions, these two uncertainties have been lumped into an estimated 0.3 per cent.

## MEASUREMENTS WITH THE CALORIMETER

The only serious utilization of this calorimeter to date has been on the x-ray beam from the 70-MEV synchrotron. The natural beam is peaked and has a full angular width between half-intensity points of 2.3°. A nearly conical copper compensat-

ing filter has been interposed in the beam to "flatten" the field at the peak of the depth-dose curve in water. The electrons which are secondary to absorption of 70-MV x-rays travel many centimeters in water at an angle moderately divergent from the primary beam direction. For this reason the compensating filter must permit of higher photon flux around the periphery of a field than through the central region in order to obtain uniform ionization across the field at the depth-dose maximum. This condition is the one used in synchrotron therapy and is therefore the one to be calibrated. Figure 3 shows the effect of removing edge photons by collimation for natural and partly compensated beams.

The largest aperture available (15-cm. diameter field at 200 cm. from target), with its compensating filter, was chosen to insure uniform x-ray intensity throughout the central region of the field. Then two secondary collimators, providing very nearly 5.0-cm. and 3.5-cm. diameter fields at 200 cm., were made to be interchangeable in a temporary lead wall external to the synchrotron and there to be coaxial with the existing beam. The coaxiality was checked with x-ray films.

The x-ray beam from the synchrotron is now monitored with a parallel-plate transmission ionization chamber of special design. Because the whole chamber is irradiated and insulators exhibit a smaller resistivity when irradiated, the guard electrode was extended to cover every conceivable leakage path between the high voltage and the collector electrodes. Also, multiple plates were used, alternating high-voltage and collector, with 1.5-mm. interplate distance and with 400 volts applied:

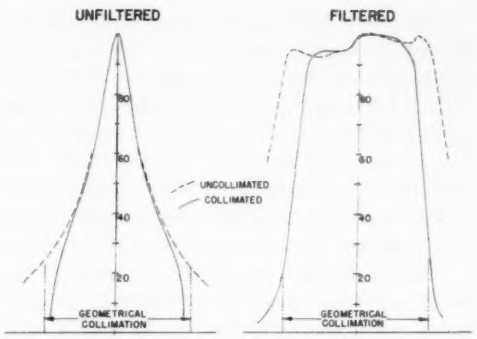


Fig. 3. A comparison of the effect of introducing a collimator (for 15 cm. diameter beam 200 cm. from target) for an uncompensated and for a partly compensated beam of 70-MV x-rays. All measurements taken at the depth of maximum ionization in Presdwood.

according to Boag (3) and Boag and Wilson (4), the collection efficiency should be about 99 per cent. The current from this chamber is read and integrated with a Victoreen Radocon, it having been necessary only to construct and mount a replacement for the first stage, which is normally in the handle of the probe of this instrument. Additionally, there was built into the amplifier circuit an artificial leakage path which may be engaged by a push button and which enables the presetting of the exposure to an uncertainty less than 0.1 monitor integration unit (here labeled MU), that is, less than 0.05 per cent of the typical exposure. The air temperature in the monitor chamber is followed only by a thermocouple and, although the maximum correction seen for runs substantially longer than these heating runs was about 3 per cent, it is conceivable that perhaps 0.5 per cent error could arise from malcorrection for change in temperature.

TABLE I: CALORIMETER CONDITIONS AND RESULTS

| Series | Beam* | Distance† | Cube‡ | mj§/MU | Correction Factor | mj/cm.²*/MU |
|---|---|---|---|---|---|---|
| A | 5.0 | 200 | W | 12.07 | 1.065 | $0.649_4$ |
| B | 5.0 | 200 | E | 12.05 | 1.065 | $0.648_2$ |
| C | 3.5 | 200 | E | 5.954 | 1.047 | $0.648_0$ |
| D | 3.5 | 285 | E | 5.798 | 1.065 | $0.642_2$ |
| E¶ | 3.5 | 285 | E | 1.768 | 1.065 | $0.195_8$ |

* Field diameter (cm.), 200 cm. from target. † Distance (cm.), target to center of tube. ‡ Cube x-irradiated (west and east). § Millijoules per monitor unit. ¶ 62.8-cm. water phantom interposed.

The lead cubes do not absorb all the energy incident upon them. The determinations of correction factors listed in Table I are given in Appendix A for the escaping photon flux and in Appendix B for escaping neutrons. Preliminary experiments, not reported here because a different exposure integration scheme was used, ascertained equivalence of the two cubes and independence of apparent beam energy content with calorimeter-target distance providing suitable allowance was made for changing amount of leakage radiation.[2] The runs reported here include one series each for a variety of conditions: changing cube, changing field size, and changing beam intensity but not energy content. The results are about what might be expected from the potential uncertainties listed above, giving the maximum uncertainty as 1.2 per cent and the standard deviation 0.7 per cent. Most of this uncertainty is in the monitor air temperature.

Series E measures the energy transmitted through the water phantom. Combining this value with the average of series A–D gives an apparent transmission of 0.303. Three runs were also made to estimate the transmission through a 10-cm. lead block, which was used as a substitute for the calorimeter cubes. The results are: 1.8, 2.8, and 3.2 $\times$ $10^{-3}$ mj/(cm.$^2$ MU), thus indicating a mean absorption ratio of 230 or a leakage correction of about 0.44 per cent. Apropos of the uncertainty discussion above, we note that the spread of values in these lead transmission determinations is less than 0.3 per cent of unattenuated beam energy determinations.

[2] Also, a beam energy calibration of the monitor made with the calorimeter seven months prior to the runs reported here gave a mean value of $0.65_2$ mj./(cm.$^2$ MU). The uncertainty of this result is about $\pm 2.0$ per cent.

### WATER PHANTOM: DESCRIPTION AND USE

The water phantom is an open-top box made of 3/4-in. plywood, paraffin impregnated, 51.4 cm. high $\times$ 54.9 cm. wide $\times$ 62.8 cm. long (external dimensions). There is a front port, 15.9 cm. in diameter, and with a 0.003-in. Al sheet retaining the water, to permit reasonably close approach of a probe to the water surface when a horizontal x-ray beam is being investigated. On the top of the box is secured a system of lead screws and ways sufficient to move a probe to nearly any point within the box by independent controls of motions in three mutually perpendicular directions. Each such degree of freedom is remotely controlled with selsyns, and revolution counters are attached to the motions at the remote control panel. The only interesting fact about this system is that the maximum wobble of a probe while being moved by any one of the control motions is about 0.5 mm. Considerable revision of the original mechanical design was required to achieve this condition.

The system used to assess and record relative ionization throughout the water

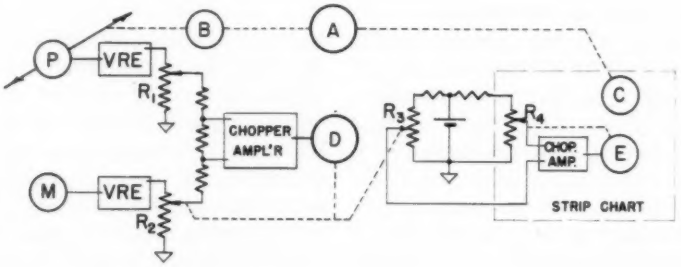


Fig. 4. Block diagram of the circuits employed to plot beam shapes and depth-dose curves as obtained with a small ionization chamber probe in a water phantom. Operation is outlined in the text.

phantom is illustrated in Figure 4. The operation is as follows: Ionization currents from the transmission monitor ($M$) and a probe ($P$) are amplified by vibrating reed electrometers ($VRE$), and the difference between the outputs is presented to a chopper amplifier which causes motor $D$ to turn and therefore adjust $R_2$ until the difference signal vanishes. $R_1$ is made manually variable to set the scale factor. Note that a variation in x-ray intensity produces a simultaneous and equal fractional change in both monitor and probe so that the position of $R_2$ for zero difference signal is unchanged; the sensitivity, however, does depend on the x-ray intensity.

Motor $A$ simultaneously drives selsyns $B$ and $C$. The recording potentiometer was modified so that selsyn $C$ would drive the strip chart in either direction. Selsyn $B$ can, by switching, be any one of the three degrees of freedom for moving a probe in the phantom. Thus, one sets two coördinates of the probe manually and then engages $A$ to move simultaneously the probe and the chart paper. As the ionization signal from the probe changes with position, motor $D$ simultaneously adjusts $R_2$ to maintain balance and $R_3$ to give a proportional signal for inducing the deflection to be recorded on the strip chart. Depth-dose curves and beam shapes are obtained by employing separately the three motions available for the probe.

One precaution that is taken before (and frequently after) making a record for analysis is to vary wilfully the x-ray intensity in order to assure the uniqueness of the indication presented to the chart while the probe remains motionless. The scales on the vibrating reed electrometers are not precisely as indicated and the output is not precisely proportional to input voltage. When corrections for non-linearity with scale and with function of scale indication, are made and when it is realized that only relative values are important here, it seems unlikely that the uncertainty can exceed 0.3 per cent.

The result from the calorimeter runs to be used with measurements from the water phantom is the amount of energy per monitor unit which was not transmitted through the phantom. Apart from a small correction for side leakage, which is estimated later, this energy is absorbed in the water. If we accept the principle upon which the Bragg-Gray relation is founded, namely that the ionization current from a small cavity chamber is proportional to the local absorbed dose rate, we now require an integration of the probe response over the volume of the phantom box. This integral has been determined for both fields and for each in two parts, ($a$) a cylinder just including the beam and ($b$) the rest of the bath. Fortuitously, the numerical integration was simplified by this separation, but the original reason was to permit a density correction between them. The estimation of the electron spectrum in the beam is outlined in Appendix C.

For the analysis in the beam, transverse transits are made through the beam in mutually perpendicular directions and each direction is traversed in both senses, for example up-to-down and later down-to-up. In order to secure good definition particularly at the beam edges, a guarded ionization chamber probe[3] was developed. This has an air volume of approximately 3 cu. mm. and may be immersed in water. This probe was used for all readings taken in and near the beam. The average response in each quadrant is computed at 0.5-cm. intervals from the beam axis, is corrected for scale non-linearity, and is converted to per cent of peak ionization. These average per cent ionization values are multiplied by the radius and plotted against radius. The terminal radius was chosen to include all of the beam at the rear of the phantom and was 3.5 cm. for the 5-cm. beam and 2.5 cm. for the 3.5-cm. beam. Integrating the area under the curve plotted as above and dividing by $\int r\,dr$, limits for both being zero and the appropriate terminal radius, gives the mean per cent ionization over the area considered and at the depth in the phantom at which the measurements were made. For each

[3] Construction to be described elsewhere.

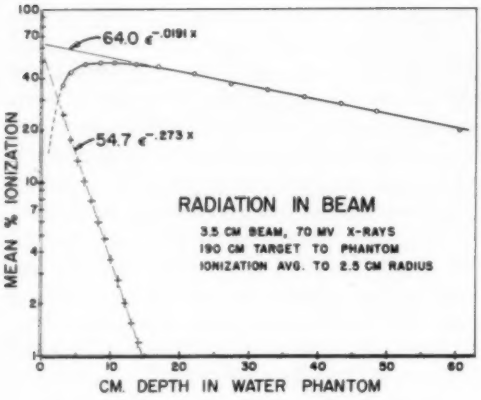


Fig. 5. The mean ionization, expressed as per cent of peak ionization, averaged over a circular area 2.5 cm. in radius and coaxial with the x-ray beam. Fourteen such averages were determined at selected depths in the water phantom. The line determined by the crosses is the difference between the line determined at large depths and the experimental curve.

beam size this process was iterated fourteen times for a selection of depths from front to rear of the phantom. Figure 5 displays the result of this procedure for the 3.5-cm. beam. These points appear quite well represented by the analytical form:

$$_1I_{3.5} = 64.0e^{-0.0190z} - 54.7e^{-0.273z} \text{ per cent} \quad (12)$$

The corresponding expression for the 5-cm. beam is

$$_1I_5 = 63.0e^{-0.0173z} - 47.8e^{-0.208z} \text{ per cent} \quad (13)$$

These two expressions are integrated analytically through the phantom and yield $4.18 \times 10^4$ and $8.68 \times 10^4$ c.c.%, respectively.

Because of the very small ionization found at substantial distances from the beam axis, the analysis outside the beam was made from the response of a chamber having an active volume of 3.14 c.c. These readings were normalized to those from the small probe by comparing responses in a larger field. Extended transits of this chamber were made, transversely from side to side of the phantom at several depths and also longitudinally from front to back of the phantom, parallel to the beam axis, at five selected distances from the beam axis. For each longitudinal transit it was noticed that the maximum deviation from a median value was only about $\pm 10$ per cent. Figure 6 shows the results of this investigation with the 5-cm. beam for two transverse transits and the average values of the five longitudinal transits. These data are fitted by the sum of two decreasing exponentials:

$$_2I_5 = 9.32e^{-0.867z} + 0.628e^{-0.198z} \text{ per cent} \quad (14)$$

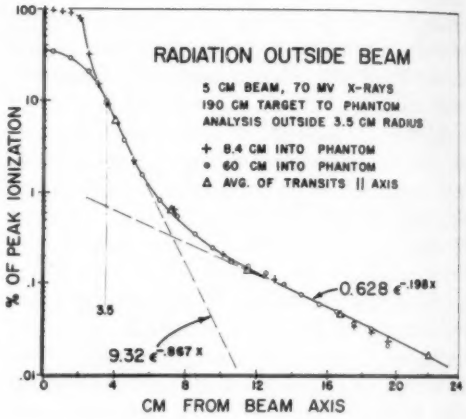


Fig. 6. Ionization in water phantom measured normal to the beam axis and expressed as per cent of peak ionization. The portion used in the analysis is exterior to the 3.5-cm. radius indicated, and the experimental curve appears well satisfied by the two exponentials, which are drawn as dashed lines.

The corresponding expression for the 3.5-cm. beam is

$$_2I_{3.5} = 9.87e^{-1.050y} + 0.566e^{-0.234y} \text{ per cent} \quad (15)$$

in which $z = r - 3.5$ cm. and $y = r - 2.5$ cm., respectively.

Integrating these analytical forms outside the beam region considered above to the boundary of the phantom gives $3.00 \times 10^4$ and $1.92 \times 10^4$ c.c.%, respectively. The energy leakage from the several surfaces of the phantom is integrated from the value of Equation 14 or 15 at each surface after multiplication by the area of the surface and division by the apparent absorption coefficient. Applying this principle, the leakage corrections are 0.27 and

0.13 c.c.%, respectively. By adding this correction to the integral inside the boundary, a number is obtained which should be proportional to the total energy outside the beam region (would be absorbed in an infinite phantom) and due to beam attenuation in the thickness of the phantom. It should be compared to the calorimetric determination of the total beam energy decreased by the energy transmitted through the phantom.

Before the intra- and extra-beam portions of the integral are added, the relative density effect correction must be estimated. In Appendix C an approximation is developed for the electron spectrum in the beam. This spectrum was used at each energy as a weighting function for the density correction according to Sternheimer (18). The result in water is that the corrected rate of energy loss is 0.845 of the uncorrected rate.

The corresponding correction figure outside the beam has been crudely estimated. The photon flux and electron flux in this region are considerably degraded compared to the beam situation: for example, a 20-MEV photon which is Compton scattered through 30° is reduced to 3.2 MEV, and the annihilation radiation from positrons is 0.51 MEV. From very rough arguments, it seems unlikely that the density correction will be substantially different from 5 per cent as an average throughout this region, and a relative correction of 10 per cent will be used to add the integrals from the two regions.

The useful portion of the radiation for our purposes is in the beam, and we shall therefore take the intra-beam integral as the standard and correct the extra-beam integral so that, in effect, the two percentages refer to the same maximum. In particular, we multiply the latter by 1.10 and add to the former, giving $12.28 \times 10^4$ and $6.43 \times 10^4$ c.c.%, or $12.25 \times 10^4$ and $6.41 \times 10^4$ gm.%, since the density of water at 21° C. is about 0.9980 gm./c.c.

Finally, for the 5-cm. field we have as the energy absorbed in the phantom per monitor unit:

$$(1 - 0.303)0.647 \times 10^4 \text{ ergs/(cm.}^2\text{ MU)} \times 19.80 \text{ cm.}^2 = 8.90 \times 10^4 \text{ ergs/MU},$$

which is represented also by the ionization integral and, by division,

$$\frac{8.90 \times 10^4 \text{ ergs/MU}}{12.25 \times 10^4 \text{ gm.\%}} \times \frac{100\% \text{ (peak)}}{100 \text{ ergs/gm. rad}} = 0.727 \text{ rad/MU}.$$

The comparable calculation for the 3.5-cm. field gives 0.674 rad/MU.

## MONITOR COMPARISONS WITH OTHER DETECTORS

Perhaps the most obvious comparison with the transmission monitor is the response of the small probe used for beam shape analysis at the peak of each beam used. Beam shapes were plotted in immediate succession at the depth dose maximum for the 3.5-, 5.0-, and 15-cm. beams with the front surface of the water phantom 190 cm. from the target. The relative peak values are obtained either from the plots or from absolute responses as indicated by the electrometer. Taking the response for the 15-cm. beam at 1.000, the response for the 5-cm. beam is 0.780 and that for the 3.5-cm. beam is 0.722, both with an apparent uncertainty less than 1 per cent. The ratio of responses between 5- and 3.5-cm. beams is 1.081, which may be compared to the ratio of energy absorptions determined in the previous section, namely 1.078. The remarkable agreement between these ratios is considered fortuitous, since the numerical integrals are probably uncertain by 3 per cent or so. In fact, the value of this integral is the weak point of the whole experiment, and alternate (chemical) methods are under development to improve the evaluation of the total energy absorption in the bath.

Considered as a working first approximation the postulate that the density effect correction in the 15-cm. beam is not greatly different from that estimated for the narrow beams, the ratio of probe responses can be used to infer the energy calibration for the 15-cm. beam. Thus,

TABLE II: DETECTOR RESPONSE

| Detector | Environment | Beam Energy Requirement |
|---|---|---|
| Extrapolation chamber | Water | 5990 $\frac{\text{erg cm.}}{\text{esu}}$ |
| Victoreen thimbles | Presdwood | 6670 $\frac{\text{erg}}{\text{cm.}^2\text{ "r"}}$ |
| Victoreen thimbles | 11.5-cm. Lucite | 8160 $\frac{\text{erg}}{\text{cm.}^2\text{ "r"}}$ |
| Victoreen thimbles | $\frac{1}{8}$-in. Pb cap | 2130 $\frac{\text{erg}}{\text{cm.}^2\text{ "r"}}$ |

the average from the two narrow beam calibrations gives 0.933 rad/MU for the 15-cm. beam.

The absolute ionization at the peak in water of the 15-cm. beam has been determined by comparing the ratio of responses of several ionization chambers to this peak and to the peak in an alternate Presdwood phantom, followed by an absolute measurement in the Presdwood phantom. The absolute measurement is obtained from an extrapolation chamber and a calibrated input resistor to one of the vibrating reed electrometers. The extrapolation chamber contains a complete guard electrode and provisions for extrapolating to zero volume either by varying the gap at constant effective area or by varying effective area at constant gap. In addition, the guard electrode can be maintained at the same potential as the collector electrode. Correcting the observed ionization for electrometer scale, for recombination loss, for conversion to peak in the water bath, and to 760 mm. Hg and 0° C., we find 1.080 esu/c.c. per MU. Dividing the energy calibration by this result, we have 0.863 rad per esu/c.c.

Selected Victoreen thimble chambers have been irradiated in the 15-cm. beam under a variety of circumstances. Readings taken are reduced by application of a $Co^{60}$ correction factor and are corrected to 760 mm. Hg and 22° C. The unit of the corrected reading will here be labeled "r." The average response of five thimbles (exposed in Presdwood in groups of three at the peak of the 15-cm. beam, with the thimble centerlines at 200 cm. from the target) is 0.970 "r" per MU.

Victoreen thimbles have also been irradiated a few times in a 1/8-in. Pb cap and in an 11.5-cm. Lucite cube, as suggested in National Bureau of Standards *Handbook No. 55*. Table II summarizes the beam energy density needed for unit detector response under the circumstances cited. We note a very substantial disagreement, many times repeated, between esu/c.c. determined from parallel-plate chambers and "r" from Victoreen thimbles with a $Co^{60}$ correction factor.

It should be noted that values related to the first in Table II and reported earlier by the author (1) were in error in absolute magnitude, largely because the input resistor had changed from an earlier calibrated value. The ratio reported there should still be correct. Although not directly comparable, the 590-cm. value given in the earlier report should in fact be close to the first value given in Table II.

## DISCUSSION AND SUMMARY

An experimental method is presented for determining absorbed dose in water. The method employs a calorimeter to measure the energy content of an x-ray beam and requires detailed knowledge of the absorption of most of this energy in a water bath, considered tissue-equivalent for these purposes. The method is applied to two narrow beams of x-rays from a 70-MEV synchrotron. Although the x-ray spectrum changes slowly with zones of these beams, the x-ray intensity is essentially constant for all zones.

The beam energy requirement to produce ionization (5,990 ergs/cm.$^2$ per esu/c.c.) is close to expectation (13). The only other known determination at approximately this energy (14) was made with an uncompensated x-ray beam and therefore is not comparable. In fact, it appears that all calorimetric applications to x-ray beams, excepting a few for 22-MV x-rays and this one for 70-MV x-rays, have been made with beams of nonuniform intensity.

The calibration made for the narrow beams was extended to larger fields, for

the largest of which the result of importance is 0.86 rad per esu/c.c. As mentioned earlier, microcalorimetric determinations of absorbed dose have been made in materials other than water and so are not directly comparable with this result. The result quoted carries an uncertainty of about 5 per cent, most of which arises from the evaluation of energy absorption in the water phantom.

The chief aim of this experiment was to compare an experimental determination of rad per esu/c.c. with a calculated value. It seems clear that our result will compare favorably with the value calculated from any reasonable theory which includes the density correction. On the other hand, the experimental uncertainty of 5 per cent is considered so large as to invalidate critical comparison at this time.

## APPENDIX A

### *Calorimeter Correction for Photon Leakage*

The correction to the calorimeter calibration of beam energy per monitor unit which is associated with photon leakage through the sides of the calorimeter cubes was estimated by making ionization measurements around a similar lead cube suspended in air. The distance of this cube from the target was made the same as that for the calorimeter cubes during the energy calibration runs. The ionization chamber was constructed of polyethylene and contained a guard electrode. The active volume is cylindrical, 8.1 cm. in diameter by 1.0 cm. in depth. This chamber was placed in a lead cave and was utilized with its center at a distance of 35 cm. from the center of the cube. The cart on which the cave and chamber were supported could be moved to any angle around the cube except within 43° directly on either side of the incident beam. Paraffin plus cadmium neutron shielding was provided external to the lead cave in order to reduce the background ionization.

Measurements of the ionization current were made throughout the available angular range with and without the lead cube in place. The background correction (without cube) was typically one-third of the reading with the cube. Angles in the neighborhood of 180° did not permit readings without the cube, for then the direct beam would interact with the cave-chamber structure. The background was estimated here by extrapolation. Since the cube was not precisely centered on the x-ray beam, the geometric mean between the measurements at

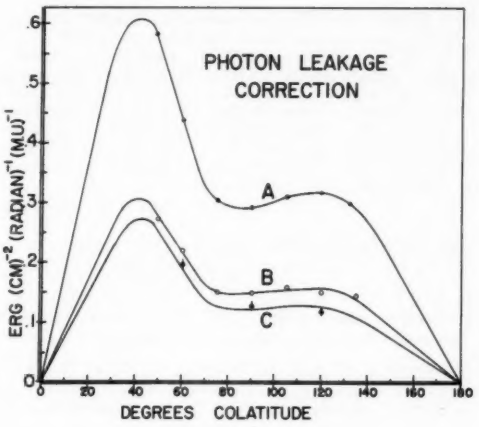


Fig. 7. Result of ionization measurements around a 10-cm. lead cube at various angles with respect to 70-MV x-ray beams. The ordinates include the *sin θ* solid angle factor and also an energy conversion obtained from use of 1,000-kvp x-rays.

corresponding angles on either side of the beam was used to represent that angle in analysis. The cube was then rotated 45° about the beam axis so that the chamber would see an edge of the cube rather than a perpendicular flat face, and a new set of measurements was made. These were regularly 84 per cent of the first set, and the two have been averaged. The above pertains to the 5-cm. field; subsequent measurements were also made for the 3.5-cm. field, first with the cube at 200 cm. and then at 285 cm. from the target.

The radiation coming from the cube was examined briefly. The soft component (presumably electrons) was completely absorbed by 0.5 cm. polyethylene. The penetrating component had an absorption coefficient of 0.50 ± 0.02 cm.$^{-1}$ in Pb and primarily consists of 0.51-MEV photons from positron annihilation or photons of about the same energy from Compton scattering through substantial angles. For the actual measurements, 1-cm. polyethylene was used to absorb the soft component. The x-radiation from a 1,000-kvp x-ray generator was considered adequately similar to the photon spectrum actually experienced to calibrate this correction. An average value of 2,900 ergs/cm.-roentgen (13) was used for the analysis, and the ionization current related the 1,000-kvp calibration to the situation being calibrated.

We compute numerically the integral

$$2\pi r^2 \int_0^{\pi} I(\theta) \sin\theta \, d\theta$$

where $r$ is the measurement distance, 35 cm., by plotting $I(\theta)$ *sin* $\theta$ against $\theta$ and determining the area under the curve. Figure 7 shows the curves for the three cases involved, being $A$, $C$, and $B$ in the order mentioned above. The ordinates have been con-

TABLE III: ENERGY LEAKAGE CORRECTION

| Condition | Beam | Distance | mj* / MU | Photon Correction | Total Correction |
|---|---|---|---|---|---|
| A | 5.0 | 200 | 0.647 | 0.0537 | 0.0649 |
| B | 3.5 | 285 | 0.316 | 0.0541 | 0.0649 |
| C | 3.5 | 200 | 0.265 | 0.0455 | 0.0474 |

* Millijoules per monitor unit

verted from the millivolts observed to energy units by means of the 1,000-kvp x-ray calibration.

Table III lists the result of this analysis. The correction factor given in the last column has been determined by multiplying the photon leakage of condition *A* by 1.04 to include the energy in associated electrons, and to this product 0.0044 has been added to account for direct beam transmission, as suggested by the calorimetric measurement of this circumstance, and 0.0047 to account for neutron leakage as estimated in Appendix B. The factor for condition *C* is reduced by the additional absorption resulting from the existence of 0.75 cm. Pb around the beam (at $\mu = 0.50$ cm.$^{-1}$) before adding 0.0091 for beam transmission and neutron leakage.

## APPENDIX B

### *Calorimeter Correction for Neutron Leakage*

Photons of energy in excess of approximately 8 MEV can produce nuclear transmutations involving the generation of neutrons. The energy consumed in liberating the neutrons augmented by their kinetic energy is lost in so far as heating of the cube is concerned. The neutron kinetic energy spectrum appears to have a mean value of approximately 1.3 MEV (15).

This correction is computed by assuming that 10 MEV are consumed for each neutron produced and estimating the number of neutrons formed from spectrum and cross-section arguments. Specifically, the bremsstrahlung spectrum of Schiff (17) was modified by the attenuation expected in the porcelain donut wall and in the copper field-compensating filter. As modified, this spectrum was used as a weighting function on the data of Jones and Terwilliger (9, 19)—pertaining to the cross section for neutron production for photon energies up to 70 MEV—in order to obtain the number of neutrons participating at each energy. At 10 MEV per neutron, this correction amounts to 0.47 per cent of the incident energy.

## APPENDIX C

### *Electron Spectrum in a Small Beam of 70-MV X-Rays*

Before estimating an electron spectrum for the small beams used in this experiment, we recall Figure 3, from which it is seen that the absorbed

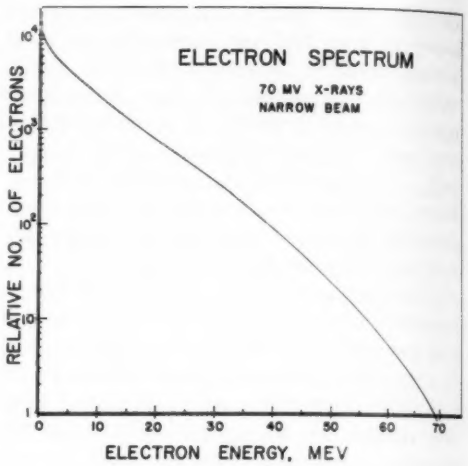


Fig. 8. Approximate electron energy spectrum for a narrow beam of 70-MV x-rays. The curve represents an initially formed spectrum which is augmented by degraded electrons arising from photon absorptions nearer the surface of the water phantom.

dose in the exterior 3-cm. annulus of a 15-cm. (at 200 cm.) field is significantly altered by the act of collimation. Apparently, the high-energy electrons secondary to absorption of 70-MV x-rays diverge enough from the direction of the x-ray beam to move laterally a few centimeters in a mean range of 10 cm. or so. Thus, extremely abrupt termination of absorbed dose will not be possible at the edges of a beam, and each beam shape to be used in therapy will require a specially shaped compensating filter to achieve a flat field at the depth-dose maximum for each.

It would also appear that secondary photons will depart from the beam, slowly but inexorably. Thus at any point in the beam appreciably beyond the depth-dose peak, the electron spectrum should be roughly constant and should be an initial spectrum, for example as calculated by Cormack and Johns (5), which, however, must be augmented by those degraded electrons formed nearer the surface which have adequate energy to reach the point in question.

The Schiff spectrum was attenuated by the donut wall, the compensating filter, and 10, 20, 30, and 50 cm. of water. Since the water produces relatively little distortion of the spectrum, the 20-cm. shape was chosen as representative, and the number of electrons produced per MEV interval was calculated from known absorption coefficients for Compton effect and pair production. A convenient but not too accurate assumption was then made that the electron spectrum includes all possible contributions from smaller depths. This is substantially true at the beam axis but is only partially true at the beam edge. It permits the spectrum to be estimated by adding together the initial spectrum per MEV

interval, progressively, and by starting with the maximum energy interval. Figure 8 shows the electron spectrum derived by this procedure.

ACKNOWLEDGMENTS: The production of the instruments used for the work described and the refinement of technic both passed through evolutionary stages. The author wishes to express sincere gratitude to Mrs. Helen E. Jones, Mr. Norman E. Scofield, and Dr. David L. Dye for technic and for operational assistance in the early stages; to Mr. Edmund Wong for steady and precise operation of the synchrotron during these runs; and above all to Mr. Henry D. Steier for flawless construction of the calorimeter and the special ionization chambers needed.

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## SUMMARIO IN INTERLINGUA

### Le Determination Experimental Del Energia Absorbite In Aqua Ab Un Fasce De Radios X

Es presentate un methodo experimental pro determinar le dose de radiation absorbite in aqua. Le methodo usa un calorimetro pro mesurar le contento de energia in un fasce de radios X e require un cognoscentia detaliate del absorption del plus grande parte de iste energia in un banio de aqua, que es considerate—pro le presente objectivos—como le equivalente de histos corporee. Le methodo es applicate a duo anguste fasces de radios X ab un synchrotron a 70 MEV. Ben que le spectro de radios X se altera lentemente con zonas de iste fasces, le intensitate de radios X es essentialmente constante pro omne zonas. Le energia de fasce requirite pro producer ionisation (5.990 ergs/cm$^2$ per ues/cm$^3$) es proxime al valor expectate.

Le calibration effectuate pro le fasces anguste esseva extendite a campos plus large. Pro le plus large de istos le resultato de importantia es 0,86 rad per ues/cm$^3$. Iste resultato es cargate per un incertitude de circa 5 pro cento. Le plus grande

parte de isto resulta del evalutation del absorption de energia in le phantasma de aqua.

Le objectivo principal de iste experimento esseva comparar un determination experimental de rad per ues/cm³ con un valor calculate. Il pare esser clar que le resultato corresponde satisfactorimente al valor calculate secundo non importa qual theoria a base solide si illo include le correction de densitate. Del altere latere, le incertitude experimental de 5 pro cento es considerate como satis grande pro invalidar comparationes critic a iste tempore.

## DISCUSSION

**H. H. Rossi, Ph.D.** (New York): I wonder if you could use a thinner slice of phantom. As I understand it, you dropped something like two-thirds of your energy in the phantom. Would your phantom be sufficiently sensitive that you could take a relatively thin slice of tissue per water and other material and by the difference determine your tissue dosage?

**Dr. Adams:** The method in principle is sensitive enough. I think the problem will be to get a sufficiently good measure of what amounts to the energy absorbed there. If we can do it by a chemical method, which is our current hope, then we can do it for thin slices or thick, equally well.

**John S. Laughlin, Ph.D.** (New York): One thing I am interested in is the changing quality of radiation at different depths of the water phantom. One indication might be by determination of the exponential at the long radial axis. I wonder if that was subject to change as you went into different depths.

**Dr. Adams:** We computed the photon spectrum at 10-, 20-, 30- and 50-cm. depths in water. As you might expect with water, there was very little change. The computation did not take into account all of the secondaries, and there was undoubtedly some quality change from this source. The experimental situation has to do with electrons secondary to the photon spectrum, and these electrons on the average seem to travel an average distance indicated by the depth-dose peak. Some electrons can penetrate to 30 cm. or so. In the case of the actual experiments we have a small x-ray beam, 3.5 to 5 cm. in diameter, and electrons (which are depositing the energy) which can move on the average of 10 cm. We have taken the 20-cm. photon spectrum as being the average for the whole bath. However, there would be very little difference had we chosen any of the others.

**G. Failla, Sc.D.** (New York): What accuracy do you claim for these measurements of the absorption of the energy in water?

**Dr. Adams:** Five per cent. Which part of it?

**Dr. Failla:** Any part of it. What I have in mind is this: If you could get a good accuracy, then you have an excellent method for determining stopping power by the old ionization scheme, such as I have been using, and then comparing that with the energy absorbed directly.

**Dr. Adams:** My point of view would be, assuming the density effect is correct, to determine the product effect, *per se*.

**Dr. Failla:** Yes, but you can use it the other way around because there is no actual experimental determination of density effect, and this would be a very good method to get the density effect.

**Dr. Adams:** Yes, the 15 per cent.

# EDITORIAL

## Bread and Butter

Problems involved in the identification and care of fractures are, like the poor, always with us. A great radiologist, Dr. W. Edward Chamberlain, once said that fractures are the radiologist's bread and butter. With that aphorism as a title, herewith are a few comments.

It is obvious that to a patient with an injury, nothing is more important than relief of his pain and some idea of how long he will be disabled. It is equally obvious that to a radiologist, especially in hospital practice, a linear fracture of the lower end of the radius may be of little medical interest when he is deeply entangled in several complicated diagnostic procedures or a full therapy schedule of patients with cancer.

Brief reflection, however, indicates that the patient who may have sustained a fracture must be seen by the radiologist and the injured part must be examined clinically. The first requirement is adequate splinting if the injury involves an extremity, and the radiologist should insist on this before the roentgen examination is begun, even to the extent of applying the splint himself. Often the patient will not have seen a doctor before arriving at the radiology department or office, because he may have been told by the referring physician over the telephone first to have a roentgen study of the injured part. Under these circumstances, if routine films of the injured area are exposed and hastily inspected, while still wet, by the radiologist who may be wearing red goggles between fluoroscopic examinations, serious mistakes of omission may occur. A minor fracture which is missed on the initial examination may result in damage to the reputation of the radiologist and referring physician out of all proportion to the medical sequelae. In personal liability cases, major inequities to either party may ensue, especially when the roentgen examination has not been extensive enough to exclude injuries at the periphery of the area of principal interest.

If a brief clinical examination by the radiologist suggests a fracture, he cannot be satisfied with negative films until a very complete roentgen study has been made. This may require modifications of technic and positioning tailored to fit the particular problem, including the more frequent use of laminagraphy. If the radiologist's clinical examination suggests other injuries besides the one for which examination is requested, he should talk to the referring physician, if possible, and indicate to him that additional examination might be advisable. If the referring physician is not available at the time, the radiologist should discuss the matter with the patient and should obtain his permission for further study.

In the examination of injured infants and young children up to the age of four or five years, clinical diagnosis as to site of injury may be quite unreliable. For this reason, a much larger area should be included in the film study, particularly when extremities are involved. It is a frequent experience to have a child of two or three years referred for roentgen study of the hip or upper leg because he refuses to walk after an injury. Many times, a fracture in the lower end of the tibia will be found if the entire leg is included on the films. Even when no fracture is seen, it is obvious that a significant injury has occurred if the young child will not walk or use an extremity. In this situation, it is important that the radiologist define the

limitations of the roentgen examination to the referring physician and suggest that re-study be considered if the symptoms continue for a week or ten days. If this is done, some of these patients will show early callus formation at the site of an incomplete greenstick fracture that could not be seen on the original films.

In older children and adults, many special problems arise peculiar to injuries in particular parts of the body. In the ankle, when symptoms persist after trauma, rupture of ligaments leading to instability may be demonstrated only by anteroposterior films exposed during forced inversion and eversion of the foot. Delayed traumatic osteochondritis dissecans of the articular surface of the talus may be shown only by oblique, tangential, or body section films designed to demonstrate the small button of sequestrated cartilage and bone, usually found on the medial aspect. In the foot, fractures of the tip of the promontory of the calcaneus may escape notice unless true lateral and various oblique projections are obtained, as well as the conventional views, and march fractures may be discovered only if re-examination at a later date is suggested, when initial study fails to show cause for symptoms. Or again, it is well known that fractures occur more commonly in the base of the skull than in the vault; yet these will usually not be demonstrated unless special views of the base (Hirtz) are made. Periorbital hemorrhage occurs with fractures of the sphenoid bone, which may be shown only by films obtained in the frontal and ethmoid sinus positions.

The frequency of whiplash injuries of the cervical spine has focused attention on the mechanism and sequelae of this injury and has resulted in extension of the technical aspects of the examination of this region, which should include anteroposterior films made with the tube angled toward the head and toward the feet, oblique views, lateral views in flexion and extension, and films of the odontoid process and base of the skull.

In any situation where obvious and extensive bony injury exists, limited roentgen survey may be all that the medical condition of the patient permits. Serious dislocations and fractures with much deformity fall into this category. When a limited roentgen study is done, a more complete examination should follow improvement in the patient's physical condition, so that an accurate record of the full extent of injury is obtained.

These are a few examples, among many, where clinical radiology pays rich dividends. Each of us must not only talk like a doctor, but must take the trouble and infinite pains to be one. Doctoring is hard work.

ROBERT P. BARDEN, M.D.

# ANNOUNCEMENTS AND BOOK REVIEWS

## EXAMINATIONS
## AMERICAN BOARD OF RADIOLOGY

A Special Examination in Nuclear Medicine for Diplomates in Radiology or Therapeutic Radiology will be held at the Palmer House, Chicago, Ill., Saturday, May 17, 1958. The deadline for filing applications is Feb. 1, 1958.

The regular examination in Radiology will be held at the Palmer House, Chicago, Ill., May 19–23, 1958. Candidates finishing their training by June 30, 1958, will be eligible. The deadline for filing applications is Jan. 1, 1958.

The Fall 1958 examination will be held at the Shoreham Hotel, Washington, D. C., Dec. 8–12. Candidates finishing their training by Dec. 31, 1958, will be eligible. The deadline for filing applications is July 1, 1958.

H. Dabney Kerr, M.D.
Kahler Hotel Building
Rochester, Minn.

## CENTRAL NEW YORK
## ROENTGEN RAY SOCIETY

At a recent meeting of the Central New York Roentgen Ray Society, the following officers were elected for the coming year: President, Dr. Paul Riemenschneider; Vice-President, Dr. Baird D. Jay; Secretary-Treasurer, Dr. Wilbur S. Brooks, General Hospital of Syracuse, 116 East Castle St., Syracuse 5.

## COLORADO RADIOLOGICAL SOCIETY

Officers of the Colorado Radiological Society for the current year are: President, James Lewis, M.D., of Colorado Springs; Vice-President, Emanuel Salzman, M.D., of Lakewood; Secretary, Lorenz R. Wurtzebach, M.D., 601 East Nineteenth Ave., Denver; Treasurer, Charles Gaylor, M.D., Denver.

## CONNECTICUT VALLEY
## RADIOLOGIC SOCIETY

Newly elected officers of the Connecticut Valley Radiologic Society are: President, Dr. Robert Grugan, Springfield, Mass.; President-Elect, Dr. Thomas J. Crowe, Northampton, Mass.; Secretary-Treasurer, Dr. Paul J. Kingston, 114 Woodland St., Hartford, Conn.

## PENNSYLVANIA RADIOLOGICAL
## SOCIETY

The Pennsylvania Radiological Society, at a recent meeting, elected the following officers: Lewis E. Etter, M.D., Warrendale, President; John H. Harris, M.D., Harrisburg, President-Elect; Joseph E. Malia, M.D., Pittsburgh, First Vice-President; Paul S. Friedman, M.D., Philadelphia, Second Vice-President; Carl B. Lechner, M.D., Erie, Editor; Walter P. Bitner, M.D., 234 State St., Harrisburg, Secretary.

## SAN FRANCISCO
## RADIOLOGICAL SOCIETY

At a recent meeting of the San Francisco Radiological Society, the following officers were elected for the coming year: President, Dr. Harold Hill; President-Elect, Dr. Earl R. Miller; Executive Board Members, Dr. Gordon King and Dr. John Bennett; Secretary-Treasurer, Dr. Irma Smith, 450 Sutter St., Suite 1124.

## WISCONSIN RADIOLOGICAL SOCIETY

Recently elected officers of the Wisconsin Radiological Society are: President, William W. Moir, M.D., Sheboygan; President-Elect, S. Richard Beatty, M.D., Neenah; Secretary-Treasurer, Farrell F. Golden, M. D., 5221 Tonyawatha Trail, Madison 4.

## SOCIEDAD CUBANA
## DE RADIOLOGIA Y FISIOTERAPIA

The Sociedad Cubana de Radiología y Fisioterapia has elected for a two-year term the following Executive Committee: President, Dr. Fidel Aguirre Medrano; Vice-President, Dr. Rafael A. Gómez Zaldívar; Secretary, Dr. Miguel A. García Plasencia; Vice-Secretary, Dr. Ernesto Fonts Bernal; Treasurer, Dr. Eduardo Rivero; Vice-Treasurer, Dr. Raúl Delgado Vargas. Monthly scientific and executive sessions are held at the Curie Hospital, Havana.

Through its newly created International Commission, the Society hopes to establish a relationship with all x-ray organizations in the world. Members of this commission are: President, Dr. Clemente Rodríguez Remus; Secretary, Dr. Eduardo Rivero, Hospital Curie, 29 y F, Vedado, Havana; Vocales, Dr. Laura Fariñas, Dr. Carlos Gárciga, Dr. Rafael A. Gómez Zaldívar.

## LOS ANGELES RADIOLOGICAL SOCIETY
## ANNUAL MID-WINTER CONFERENCE

The tenth annual Mid-Winter Radiological Conference, sponsored by the Los Angeles Radiological Society, will be held at the Biltmore Hotel, Los Angeles, Calif., on Saturday and Sunday, Feb. 22 and 23, 1958. Guest speakers will be Dr. Ralston Paterson, Manchester, England; Professor William V. Mayneord, London, England; Dr. D. L. McRae,

Montreal, Canada; Dr. E. B. D. Neuhauser, Boston, Mass.; Dr. Robert S. Stone, San Francisco; Dr. L. H. Garland, San Francisco; Dr. G. W. Beadle, Pasadena.

The conference fee of $20.00 includes two luncheon meetings featuring questions and answers. A banquet preceded by cocktails will be held Saturday evening. Reservations may be made through Dr. John H. Eaton, 65 N. Madison Ave., Pasadena, Calif.

Courtesy cards will be available to residents in radiology and radiologists in the Armed Forces by advance registration, with reduced tariff for luncheons and banquet.

Hotel reservations should be made through the Convention Manager, Biltmore Hotel, Los Angeles, Calif.

## ERRATUM

In the paper "Abdominal and Pelvic Pneumography" by Buice and Gould in RADIOLOGY for November 1957, the figure for the solubility of $CO_2$ at the top of the second column on page 704, namely, 5.45 ml./100 ml. water, is as given in one of the references (6). According to Teschendorf and the authors' own recent experiences, this should be, instead, 54.5 ml./100 ml. water and the last sentence in the paragraph should be changed to read: "It is slightly *less soluble* than carbon dioxide, the gas now most widely used." The last sentence on page 706, running over to page 707, should be deleted altogether.

## SOCIETY OF NUCLEAR MEDICINE

The fifth annual meeting of the Society of Nuclear Medicine will be held in Los Angeles, Calif., June 19–21, 1958. The program will include scientific sessions, training courses, a seminar on teaching, scientific tours, a scientific exhibit, a continuous exhibition session, two business meetings, a banquet, and two luncheon meetings.

On Thursday night there will be a seminar on teaching problems in the use of radioactive isotopes under the chairmanship of Dr. J. Sternberg of Montreal, Canada. A number of scientific tours for Saturday afternoon are being arranged by Dr. Henry Jaffe.

Reservations should be made at the Beverly Hilton Hotel. Additional information may be obtained from the Secretary of the Society, R. W. Lackey, M.D., 452 Metropolitan Building, Denver, Colo.

## ATOMIC ENERGY COMMISSION PUBLICATIONS

A report entitled *Radioactive Contamination of Certain Areas in the Pacific Ocean from Nuclear Tests—A Summary of the Data from the Radiological Surveys and Medical Examinations*, edited by Dr. Gordon M. Dunning, has recently been published. This monograph brings together the principal data on environmental contamination from the radioactive fall-out following the March 1, 1954, thermonuclear detonation at the Eniwetok Proving Ground. It collates ten radiological surveys made in the Pacific by the Applied Fisheries Laboratory of the University of Washington, U. S. Naval Radiological Defense Laboratory, Health and Safety Laboratory at the New York Operations Office of the United States Atomic Energy Commission, and the Office of Naval Research. The report also contains pertinent excerpts of the findings of American medical teams who examined the exposed Marshallese.

This report of 54 pages has been published by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., and is sold for 40 cents.

Another recent publication of the Commission is *Atomic Energy Facts: A Summary of Atomic Activities of Interest to Industry*. This is designed to provide industry with a handbook on nuclear operations in the United States. The paper-bound book of 216 pages, with 86 figures, may be purchased for $2.00 from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

## POSTGRADUATE COURSE IN OTOLARYNGOLOGIC RADIOLOGY OHIO STATE UNIVERSITY

A postgraduate course in otolaryngologic radiology, under the auspices of the Departments of Radiology and Otolaryngology, College of Medicine, Ohio State University, will be held Feb. 4 and 5, 1958, at the University Hospital, Ohio State University Health Center, Columbus. The faculty will include John F. Holt, M.D., Professor of Radiology, University of Michigan; Lewis E. Etter, M.D., Professor of Radiology, University of Pittsburgh; Roderick Tondreau, M.D., Professor of Radiology, University of Pennsylvania; Sidney Nelson, M.D., Professor of Radiology, Ohio State University. Registrants are encouraged to bring interesting roentgenograms for participation in discussion periods.

A fee of $35.00 will be charged and must accompany the registration application. Luncheon for the two days will be included in this fee. All registrations are to be completed by Jan. 15, 1958.

Further information may be obtained from William H. Saunders, M.D., Department of Otolaryngology, University Hospital, Columbus 10, Ohio.

## CANCER SEMINAR

The Sixth Annual Cancer Seminar of the American Cancer Society in Arizona will be held in Tucson, Jan. 23–25, 1958, with specialists from five states participating. The sessions will be held in the Tucson Inn and will include lectures and panel dis-

cussions by leading authorities in the various fields relating to cancer. The Seminar is open to all physicans, surgeons, internes, nurses and dentists.

Chairman of the Seminar Committee is Dr. Darwin W. Neubauer of Tucson. Members of the Committee are Drs. Arthur A. Present, Hermann S. Rhu, Jr., Ralph Fuller, and James Fritz, all of Tucson, and Drs. Edward Bregman and James Barger of Phoenix.

## Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

PEDIATRIC ROENTGENOLOGY. By Dr. M. A. LASSRICH, Prof. Dr. R. PRÉVÔT, Prof. Dr. K. H. SCHÄFER, Hamburg. Edited by Prof. Dr. K. H. SCHÄFER, Hamburg. Translation from the German provided by JAMES T. CASE, M.D., D.M.R.E. (Cambridge), Professor Emeritus, Radiology, Northwestern University Medical School, Chicago; Director, Memorial Cancer Foundation, Santa Barbara, California. A volume of 334 pages, with 700 figures, mostly roentgenograms. Published by Grune & Stratton, Inc., New York, N. Y., 1957. Price $28.00.

BONE TUMORS. GENERAL ASPECTS AND AN ANALYSIS OF 2,276 CASES. By DAVID C. DAHLIN, M.D., Consultant, Section of Surgical Pathology, Mayo Clinic, and Associate Professor of Pathology, Mayo Foundation, Rochester, Minnesota. A volume of 224 pages, with numerous roentgenograms, photomicrographs, photographs, diagrams, and charts, and 3 tables. Published by Charles C Thomas, Springfield, Ill., 1957. Price $11.50.

ROENTGEN DIAGNOSIS OF ABDOMINAL TUMORS IN CHILDHOOD. By CHARLES M. NICE, JR., M.D., Ph.D., ALEXANDER R. MARGULIS, M.D., and LEO G. RIGLER, M.D., all from the Department of Radiology, University of Minnesota Medical School, Minneapolis, Minnesota. A volume of 76 pages, with 89 roentgenograms, 1 photograph, and 5 diagrams. Published by Charles C Thomas, Springfield, Ill., 1957. Price $4.00.

BIOLOGICAL EFFECTS OF WHOLE-BODY GAMMA RADIATION ON HUMAN BEINGS (U). By HAROLD O. DAVIDSON. A volume of 102 pages, with charts and tables. Published for Operations Research Office, The Johns Hopkins University, by The Johns Hopkins Press, Baltimore, Md., 1957. Price $3.00.

THE BIOLOGIC BASIS OF CANCER MANAGEMENT. By FREDDY HOMBURGER, M.D., Research Professor of Medicine, Tufts University School of Medicine; Scientific Associate, Roscoe B. Jackson Memorial Laboratory. Forewords by Lauren V. Ackerman, M.D., Clarence Cook Little, Sc.D., Alton Ochsner, M.D. A volume of 354 pages, with 10 figures and 39 tables. Published by Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, New York, N. Y., 1957. Price $10.00.

DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS. A COMPLETELY REVISED AND ENLARGED EDITION OF HANDBOOK OF DANGEROUS MATERIALS. By N. IRVING SAX, Consultant on Industrial Safety, Nuclear Development Corporation of America, White Plains, N. Y. Assisted by Leonard J. Goldwater, Professor of Occupational Medicine, Columbia University, New York, N. Y.; William B. Harris, Chief, Industrial Hygiene Branch, Health and Safety Laboratory, U. S. Atomic Energy Commission, New York, N. Y.; John H. Harley, Chief, Analytical Branch, Health and Safety Laboratory, U. S. Atomic Energy Commission, New York, N. Y.; Joseph J. Fitzgerald, Supervisor of Radiological Chemistry and Physics, Knolls Atomic Power Laboratory, General Electric Company, Schenectady, N. Y.; Milton S. Dunn, Medical Director, Rensselaer Division, General Aniline and Film Corp., Rensselaer, N. Y. A volume of 1467 pages, with 21 figures. Published by Reinhold Publishing Corporation, New York, N. Y., 1957. Price $19.50 until end of December 1957; $22.50 beginning January 1958.

WORLD DIRECTORY OF MEDICAL SCHOOLS. Second edition. A volume of 314 pages, with map of population per physician. Published by World Health Organization, Palais des Nations, Geneva, Switzerland, 1957. Distributed in the United States of America by Columbia University Press, International Documents Service, New York, N. Y. Price $5.00.

## Book Reviews

INTESTIN GRÊLE: COLON—RECTUM. By G. ALBOT, ET AL. Under the direction of GUY ALBOT, Médecin de l'Hôtel-Dieu, Paris, and FÉLIX POILLEUX, Chirurgien de l'Hôpital Corentin-Celton. Actualités hépato-gastro-entérologiques de l'Hôtel-Dieu, 1955. A volume of 362 pages, with 168 illustrations. Published by Masson & Cie, 120 Boulevard Saint-Germain, Paris 6e, 1956. Price 3,400 francs.

This small volume presents a series of conferences on gastroenterology held in 1955 at l'Hôtel-Dieu. The subjects discussed include regional enteritis, obstructive syndromes of the small intestine, tumors of the small intestine, cancer of the right side of the

colon, ulcerative colitis, megacolon, colonic polyposis, the long-term results of surgery for cancer of the rectum, the early diagnosis of tumors of the rectum and their treatment, and finally sigmoid diverticulitis.

The subjects are considered in detail from their clinical, pathologic, radiologic, and therapeutic aspects. The radiologic considerations in general play a subordinate role in these discussions.

The illustrations and printing are good. The volume will probably be more useful to the clinician, but the radiologist will find much of interest in its pages.

KURVEN UND TABELLEN FÜR DIE STRAHLENTHERAPIE. By Dr. FELIX WACHSMANN, Privat-Dozent für medizinische Physik, Universität Erlangen, Erlangen, Germany, and Dr. ALEXANDER DIMOTSIS, zur Zeit wissenschaftlicher Assistent, Universität Erlangen. (In German, English, French, and Spanish.) A volume of 184 pages, with numerous charts and tables. Published by S. Hirzel Verlag, Stuttgart, Germany, 1957. Price DM 28.—

This book fills a real need since it contains in one handy volume a vast amount of information which otherwise is spread over a widely scattered area of international literature. In addition, the total material from the title page to the index is presented in German, English (translated by Mr. Wall, Erlangen), French (translated by Dr. Herve, Lüttich), and Spanish (translated by Dr. Belloch, Madrid). Not only will this four-language publication be useful to a very large group of readers but it also offers the individual reader who is interested in languages the opportunity to learn automatically the translations of technical terms into languages other than his own.

A large part of the book is devoted to the presentation of percentage depth-dose curves and tables for a wide range of roentgen rays of qualities from 0.01 mm. aluminum up to 15 mm. copper half-value layer. In general there is good agreement between the percentage depth doses given in this book and those used for identical conditions in America. For radiation of half-value layers in the neighborhood of 2 mm. of copper, however, and for large areas, the depth doses seem to be up to 8 per cent higher than those commonly employed here. There are additional depth-dose tables for cobalt-60 teletherapy, for supervoltage machines up to 100 million volts, for contact therapy apparatus, and for several types of pendulum and rotation therapy machines.

The book opens with a general section on chemical elements, isotopes, ranges of electrons, protons, neutrons, deuterons, and alpha particles, and specific ionization. This is followed by a chapter on definition and measurements of radiation quantities and qualities for a large variety of conditions. Another section deals with natural and artificial radioisotopes, their properties and their uses, dosage definitions, and tables. The concluding pages are devoted to biological considerations, effects of radiation, skin tolerance, effect of radiation quality on the erythema dose, effect of protracted treatment on various biological tissues, and various methods of grid therapy.

This valuable reference work should be in every library, and for radiological and biophysical libraries is a "must." Incidentally, it contains such a wealth of useful material that, to keep it down to a reasonable size, many of the tables appear in what must be the smallest type ever used in a scientific book.

# ABSTRACTS OF CURRENT LITERATURE

## ROENTGEN DIAGNOSIS

**The Musculoskeletal System**



**The Genitourinary System**



**Miscellaneous**



## RADIOTHERAPY



## RADIOISOTOPES

## RADIATION EFFECTS

## ROENTGEN DIAGNOSIS

**Periodic Roentgen Examination—Drudgery or Challenge?** Leo G. Rigler. J.A.M.A. **163:** 530–534, Feb. 16, 1957. (4833 Fountain Ave., Los Angeles 29, Calif.)

This paper is concerned with the periodic examination of apparently healthy persons by the physician or clinic of their choice as distinct from the mass survey of a large heterogeneous group. The author believes it reasonable to predict that such examinations will come to represent a large part of future roentgen diagnostic practice. Whether this development is to be regarded as a challenge or as drudgery depends on the attitude of the radiologist. A "productive" procedure need not necessarily be one which reveals a large number of incurable cancers. "Would it not be far more rewarding," the author asks, "to find one minimal case of tuberculosis or one small operable cancer of the lung or of the stomach, even though one makes many hundreds of examinations to arrive at this goal?"

Two important questions need to be answered if periodic examination is to be advocated on a large scale. (1) How efficient is roentgen diagnosis in detection of disease processes in their incipiency? (2) Have any real accomplishments resulted?

In answer to the first question, it is stated that it has already been demonstrated that a lesion of the lung no larger than 3 mm. can be detected. It has also been found that carcinoma of the lung almost invariably is manifest roentgenologically before the onset of symptoms. In carcinoma of the stomach, also, roentgen findings precede symptoms, and, although this is not yet well documented, the same is probably true of carcinoma of the colon.

In relation to the question of accomplishment the author discusses the conception of biological predeterminism so far as most tumors are concerned, and the skepticism to which it has given rise. He points out that, while it is true that there are tumors that are so malignant that death will result regardless of the speed or intensity of the therapeutic procedure and others which are so indolent that speed in the application of therapy is not essential, there is a third class within each group that is curable providing treatment is instituted within a certain period of time. Numerous series, large and small, are cited, with correlation of resectability, lymph node involvement, and survival with the size of the neoplasm and the presence or absence of symptoms. In the case of lung cancer, this correlation indicates that curability is two to six times as great in asymptomatic patients as in those with symptoms. In one series of carcinoma of the stomach the five-year survival rate was 40 per cent better for lesions measuring 4 cm. or less and 125 per cent better for lesions under 2 cm. than for lesions of all sizes. In a series of 38 cases of gastric carcinoma from the University of Minnesota cancer detection center and outpatient clinic, the lymph nodes were involved in 6 of 22 asymptomatic cases, in 8 of 11 cases with mild symptoms, and in all 5 cases coming to operation with frank symptoms. Carcinoma of the colon has shown a four-year survival rate of 93 per cent for asymptomatic as compared to 36 per cent in symptomatic patients. Corresponding figures for rectal cancer are 78 and 33 per cent.

It is concluded that, "given the proper attitude on the part of the physician, periodic roentgen examination may be a stimulating and exciting endeavor. . . . We must not desert the few because we cannot save the many. Here is the real, the vital challenge for the future of roentgen diagnosis; the detection of cancer before the onset of symptoms."

One graph.

B. J. HILL, M.D.
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### THE HEAD AND NECK

**Roentgenographic Study of the Growth of the Skull.** L. Drey. Ann. paediat. **188:** 182–199, March 1957. (X-Ray Department, Municipal Hospital Hadassah, Tel-Aviv, Israel)

A technic for measuring the growth of the skull based on the methods of Brodie (Am. J. Anat. **68:** 209,1941) is presented. It depends on the relationship of the nasion-palatum line (which is a vertical line drawn from the nasion to the anterior end of the palatine bone) to the anterior basal line, which connects the anterior clinoid process to the nasion. The anterior basal line represents the enchondral basal growth, while the nasion-palatum line represents the growth of the maxilla.

The normal relationship of the nasion-palatum line to the anterior basal line is one to three during the first few months of life. This proportion changes with the growth of the facial bones, and the percentage ratio in the adult is between 80 and 90 per cent. (The rate of growth of the maxilla relative to the basal growth is expressed by percentage of the length of the nasion-palatum line to that of the anterior basal line.) The author shows that the quotient of the nasion-palatum/anterior basal line may be decreased in mongolism and increased in endocrine adiposity.

Other features of abnormal skull growth which may be noted radiographically are discussed. These may be associated (1) with diseases of the blood, that is, disturbances in the function of the bone marrow, or (2) with general growth disturbances.

In Cooley's anemia there are: early diploesation, exaggeration of the eccentric thickening of capsular bones, aggravated mottling with extreme flattening, and exaggerated periodical apposition of bone.

General disturbances of growth may be either quantitative or qualitative. Rickets is used as an illustration of quantitative changes. Delayed ossification of the osteoid tissue is seen roentgenologically in the form of thinned areas of linear appearance alternating with thicker areas of bone. The thinnest parts represent the accumulated nonossified osteoid tissue.

Qualitative disturbances in the development of the skull may be either those of delayed or accelerated growth. The following x-ray findings are characteristic of delayed cranial growth: (1) lack of increase of the capsular circumference during a fixed period, signifying delayed sutural expansion; (2) absence of the diploe at the age of two to three years, definitely a sign of underdevelopment; (3) failure of the anterior basal line and the nasion-palatum line to lengthen, indicating relative cessation in basal and facial growth. Accelerated growth, sometimes seen in endocrine adiposity, is demonstrated by precocious pneumatization of

the facial cavities and by a high nasion-palatum anterior basal line quotient.

Thirty figures, including 9 roentgenograms.

FRANCIS F. RUZICKA, JR., M.D.
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**Roentgen Changes in the Cranium in 153 Intracranial Tumours in Children Aged 0–15 Years.** Helge Hertz and Thomas Rosendal. Acta radiol., suppl. 141, pp. 1–54, 1956. (T. R., Sundby Hospital Roentgen Department, Copenhagen, Denmark)

The roentgen changes in the skulls of 153 children with proved brain tumors were studied. The children, ranging in age from less than a year to fifteen years, were seen at the Rigshospital, Neurosurgical Department, Copenhagen, Denmark, between 1936 and 1951. The authors' summary of their findings with some slight modification is as follows:

The material consists mainly of gliomas (77 per cent), most frequently astrocytomas (30 per cent), medulloblastomas (18 per cent), and ependymomas (15 per cent). Craniopharyngiomas and other malformations represent 7.2 per cent, whereas meningiomas, hypophyseal adenomas, and acoustic neurinomas account for no more than 1 to 2 per cent. Among adults, gliomas represent about 37 per cent of the total, and the latter group up to 50 per cent. The tumors were more frequently infratentorial (57 per cent) than supratentorial (43 per cent) and more often in the cerebellum (57 per cent) than in the cerebrum (23 per cent). Among adults the reverse is the case: in Cushing's adult material the corresponding figures are 77, 23, 49 and 10 per cent (Am. J. Dis. Child. **33:** 551, 1927).

Roentgenologic changes indicating intracranial tumor were found in 80 per cent; in 10 per cent the diagnosis was uncertain, and in 10 per cent nothing abnormal was observed. For the material as a whole, suture diastasis, sellar changes of a pressure character, or increased impressions indicated craniostasis [craniostosis?—Ed.] in 49 per cent without localization of the tumor. In 30.7 per cent, calcification in the tumor (12.4 per cent) and localized changes in the cranial wall (18.3 per cent) provided information as to the site.

The craniostatic changes characterize the roentgen picture and appear in combination with calcifications and local skull changes in 67 per cent of the material, being most frequently in the case of tumors in the pons and posterior fossa (77 per cent), less so in 66 supratentorial tumors (53 per cent) and, among the latter, least with tumors of the optic nerve and chiasma and peripherally and anteriorly in the cerebrum. Suture diastasis was found in 94 cases; it is first seen in relation to the coronal suture, and is the most frequent sign up to the age of nine years. The younger the patients the greater the degree. Sellar changes of a pressure character were found in 78 cases, and are the most frequent sign from ten to fifteen years. In over two-thirds of the cases the dorsum was osteoporotic or thinned; in barely a third the sella was dilated and the dorsum was eroded down to or near to its base. These two types of change are equally frequent in supra- and infratentorial tumors and are independent of the nature of the growth (except for tumors in or just above the sella). They are of no localizing value. Increased pressure markings were found in 54 cases, and, like diffuse thinning of the skull, contributed little to the diagnosis.

Calcification in tumors (and, in a single case, calcification in a displaced pineal body) in 12.4 per cent of the material indicated the location of the tumor and, in about half the cases, the size of the growth. Calcification is most frequent in the supratentorial tumors (21 per cent); in or above the sella it occurs only in the craniopharyngiomas (in 7 of 11 cases) and in the cerebral hemispheres, for the most part in the gliomas. It is of value in diagnosis of the nature of the tumor in cases of ependymoma, ganglioglioma, and angioma racemosum in the cerebral hemispheres. There were only 4 cases of calcification in tumors in the pons and the posterior fossa (4.6 per cent of the infratentorial tumors).

Localized changes in the lateral walls and in the base of the skull provided indications of the location of the tumor in 18.3 per cent of the entire material. The changes were found only in connection with supratentorial tumors (42.5 per cent). Changes in the lateral walls appeared as local thinness or bulging of the wall, most often in the parietal region, and in most cases were combined with signs of craniostasis. They occurred with large tumors laterally in the hemispheres, causing considerable increase of the intracranial pressure. Wall changes in the base of the skull were observable as dilatation of the optic foramen, erosion of the sulcus chiasmatis with undercutting of the anterior clinoid processes, and dilatation of the sella into a "cup" shape. The changes occurred in 15 cases (10 per cent of the whole material) of glioma of the optic nerve, the optic chiasma, anteriorly in the floor of the third ventricle, in suprasellar epidermoid, chromophobe hypophyseal adenoma and craniopharyngioma. The localization value is greatest when the tumor is so small that it has not caused craniostasis, in which case the changes can no longer be differentiated from those observable with tumors in the cerebral hemispheres, in the pons, or in the posterior fossa.

Calculations of cranial capacity, the depth of the posterior fossa, evaluation of wall thickness, and prominence of vascular markings showed no definite differences between the tumor material and measurements made in 109 normal children.

Widening of the foramen emissarium occipitale was observed only in conjunction with craniostasis.

Fifty-six roentgenograms; 10 diagrams; 6 tables.

MORTIMER R. CAMIEL, M.D.
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**Arteriographic Study of 62 Cases of Supratentorial Angiomas.** G. R. Hoffmann, J. Achslogh, J. Brihaye, A. De Reymaeker, and S. Thiry. J. belge radiol. **40:** 174–196, 1957. (In French) (Université libre de Bruxelles, Brussels, Belgium)

Sixty-two cases of supratentorial angiomas were studied by arteriography. Four types are recognized, but attention is called to the fact that there are transitional forms.

*Type 1:* Small angioma with simple arteriovenous communication. This is usually a cortical lesion about 1.0 cm. in diameter, which may be cured by ligation of the afferent vessel.

*Type 2:* Subcortical angioma of medium volume. The majority of angiomas of this type are in the white matter, attaining a diameter of 2 to 5 cm. The veins draining the lesion are moderately dilated. The demonstration of the nourishing vessels is of importance to the surgeon, since he may have to excise the mass.

*Type 3:* Large cavernous angioma. A large number of these are in the frontal lobes and receive afferent or nourishing vessels.

*Type 4:* Angioma of medium volume with great hypertrophy of the venous drainage. In these patients ligation of the afferent vessels is necessary.

Since many angiomas receive afferent vessels from both sides, bilateral carotid arteriography should be done before surgery. If an intracerebral hematoma accompanies the angioma there may be displacement of surrounding vessels.

In 95 per cent of supratentorial angiomas the diagnosis is clearly evident on arteriograms. In difficult cases there is a possibility of confusion with meningioma and certain types of glioma. Differentiation from meningioma requires careful study of the capillary and venous phases. Tumors are more likely to be surrounded by edema and thus to cause significant vascular displacement.

Twenty-three roentgenograms.

CHARLES M. NICE, JR., M.D., PH.D.
University of Minnesota

**Pseudotumor Cerebri.** Ralph Bryan Moore. Pediatrics **19:** 266–271, February 1957. (15 North Fifth St., Wilmington, N. C.)

Pseudotumor cerebri is a condition, usually acute, characterized by signs and symptoms suggesting an expanding lesion in the posterior fossa. The onset is often preceded by some mild illness or trauma, but the etiology is not known. Occasionally evidences of arachnoiditis have been demonstrated about the meninges. The clinical picture does not usually include focal signs, although paralyses of the fifth, sixth, and seventh cranial nerves do occur. There may be headache, vomiting, diplopia, papilledema, and gait disturbances. Ventriculograms usually reveal ventricles of normal size. The spinal fluid is excessive in amount but shows a normal cell count and protein content. Brain tumor must be ruled out, either by ventriculograms or exploration, to make the diagnosis.

Management consists mainly in dehydration, performance of repeated lumbar punctures, and possibly also subtemporal decompression, in order to protect against progressing papilledema and secondary optic atrophy.

The prognosis is usually fairly good, and symptoms gradually subside in a few weeks to a few months.

Three cases, in patients of six to eight years, are reported and data from the records of 3 other children are given.

Three tables.

DON E. MATTHIESEN, M.D.
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**Localization of Intraocular Foreign Bodies by Roentgen Examination. Practical Procedure.** Fernando E. Rosas. Arch. Ophth. **57:** 245–249, February 1957. (Calle 69, No. 750 A, Merida, Yucatán, Mexico)

A technic for the localization of radiopaque intraocular foreign bodies is described. It is said to be nontraumatizing and practical, requiring only the usual x-ray machine and regular silk Atraumatic suture needles. It is thought that this technic may be helpful in places where special equipment is not available, since extraction of intraocular bodies is generally considered an emergency procedure.

At the time of this report, the technic had been applied in only 3 cases, in which there existed the possibility of saving the eye, and in each instance it proved successful.

Eight drawings.

**Radiological Manifestations of Ectopic Salivary Adenomas Showing the Cylindroma Pattern.** Max J. Ryan. Proc. Roy. Soc. Med. **50:** 96–100, February 1957. (Manchester Royal Infirmary, Manchester, England)

Benign, mixed salivary adenomas, although usually located in the parotid or submandibular salivary glands, occasionally arise at other sites about the head. About half of these ectopic tumors are of the variety known as cylindroma. They grow slowly but travel extensively and tend in some cases to invade the base of the skull. They have been known to give rise to regional and distant metastases.

The author of this article reviews 55 cases and outlines the contribution which radiology can make in diagnosis and management of cylindroma. Roentgenographic manifestations have been found in the nasopharynx, the antrum, the hard palate, and the orbit. Extensive x-ray investigation is essential when the diagnosis is known or suspected in order to reveal all extensions of the tumor. Basal views of the skull may show changes in the major foramina; lateral skull films may reveal nasopharyngeal tumor masses; sinus studies and views of the facial region may show erosions or evidences of invasion about the orbits, sinuses, etc. The tumors produce their changes slowly over the years, while the patients seem usually to remain in good general condition.

There is a tendency toward the production of pulmonary metastases of the cannon-ball type. These, like the primary tumor, grow very slowly and produce few symptoms. The finding of lung lesions of this type, with little change over a long interval, is almost pathognomonic, and enables the radiologist to make "a fairly confident diagnosis."

Eight roentgenograms.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

## THE CHEST

**Traumatic Torsion of the Lung.** DeWitt C. Daughtry. New England J. Med. **256:** 385–388, Feb. 28, 1957. (University of Miami School of Medicine, Coral Gables 34, Fla.)

About 25 per cent of deaths from automobile, industrial, and farm machinery accidents are due to nonpenetrating thoracic injuries. These deaths are the result of deranged pulmonary function. Extensive rib fractures with paradoxical breathing, obstructed air passages, "wet lung," and hemopneumothorax comprise the majority of serious thoracic injuries or complications. More unusual injuries or complications are trauma to the heart and great vessels, the tracheobronchial tree, the esophagus, the thoracic duct, and the diaphragm.

The author cites one previous case report of traumatic torsion of the lung (Stratemeier and Barry: Radiology **62:** 726, 1954) and presents a case of his own in complete detail. The previously reported case was diagnosed at autopsy. X-ray studies of the thorax had revealed striations extending laterally and upward in a "curling fashion" from the left pulmonary hilus.

The author's patient was a 7-year-old girl who was injured when an automobile passed over the middle portion of her body. There were abrasions over the left lower part of the thorax. Expansion of the left lower thorax was decreased and breath sounds were diminished. X-ray study revealed fractures of the fifth through the ninth ribs at the midaxillary line. The prominent vascular pattern of the left lung swept superiorly and slightly laterally rather than downward and laterally. One hour later a chest film showed the same general findings, with the addition of slight ground-glass or granular appearance throughout the left lung field. Three hours after injury another film demonstrated a homogeneous opacity of moderate density but presenting a definitely granular or mottled appearance throughout the left lung. No lung markings were visible. The roentgen diagnosis was massive hemothorax, but an intercostal catheter introduced into the pleural space did not return any appreciable amount of blood. Three days after injury, x-ray examination again revealed a dense homogeneous opacity more pronounced over the lower half of the left side. Multiple thoracenteses produced no significant amount of blood, and further x-ray study, after twenty-three days, revealed linear streaks of aeration extending laterally from the area of the left hilus. About forty days after the injury, a thoracotomy on the left disclosed well organized parietal pleural thickening. The underlying lung appeared necrotic, and positive pressure breathing produced a great number of air leaks. When the hilar structures were approached for dissection, an abnormal relationship was apparent. The pulmonary arteries seemed to be surrounded by segmental veins. The apex of the lung was very broad, and the base seemed narrow or small. A poorly defined major fissure did not extend to the diaphragm but to about the midcardiac area.

At this time the surgeon realized that a torsion of the lung existed. This was reduced by 180° counterclockwise rotation, and all the hilar structures resumed a normal relation. The necrotic segments of lung were removed, leaving only the superior segment of the lower lobe in place. Recovery was satisfactory, and at the time of the report the remaining segment had almost completely filled the left side of the thorax.

Crushing or compressing injury of the lower thorax associated with the early x-ray finding of a vascular pattern that radiates superiorly and laterally, with rapid disappearance of breath sounds and prompt progression to a homogeneous density of a ground-glass type, should suggest the diagnosis of torsion of the lung. Hemothorax and extravasation of blood into the parenchyma may produce a similar late x-ray appearance, but can be ruled out by inability to aspirate blood by thoracentesis and the absence of blood in the bronchi upon bronchoscopy.

As to the mechanism of torsion in his case and the one previously reported, the author postulates that the sudden marked compression of the chest wall displaced the lower lobe medially and upward, tearing the very thin inferior pulmonary ligament. When the compressed, displaced and deflated lower lobe expanded as the pressure on the lower thorax was relieved, the aerated upper lobe rotated clockwise to occupy the high vacuum space that had been created in the lower thorax.

Three roentgenograms; 2 photographs.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

**Traumatic Hemopneumothorax in the Minor Pulmonary Fissure.** Henry P. Brean, Alvin S. Hambly, Jr., and J. Hallam Cope. California Med. **86:** 104–107, February 1957. (H. P. B., 2001 Dwight Way, Berkeley 4, Calif.)

Traumatic rupture of the visceral pleura lining the minor pulmonary fissure may produce encapsulated hemopneumothorax limited to the space between the right upper and middle lobes. This lesion, which may persist for several weeks, may be differentiated from cystic pulmonary lesions and from lung abscess by its constant and intimate symmetrical relation to the plane of the minor fissure as demonstrated radiologically. The posterior extremity of the lesion, in the lateral view, consists of a small dense triangle, symmetrically placed on and merging into the posterior extremity of the minor fissure at its juncture with the major pulmonary fissure. Anteriorly, the lesion merges into the minor fissure by a long pointed lanceolate density. Also, the sharp outline of the gas-pleural surface superiorly contrasts with the hazy merging of the lower border of the fluid collection with the compressed or contused lung immediately below. Laminagraphy is helpful in showing some detail, but conventional views well exposed are likely to be adequate for diagnosis. Three cases, in young men who had sustained severe chest injuries in automobile accidents, are reported.

The pathogenesis of minor-fissure hemopneumothorax in the absence of surgical exploration, remains speculative. It is suggested that a bursting or tearing of the visceral pleura lining the fissure may permit escape of air and blood into the space.

Nine roentgenograms.

**Bronchographic Findings in Pneumonia with Delayed Resolution.** O. Fischedick and L. Sieckel. Fortschr. a. d. Geb. d. Röntgenstrahlen **86:** 203–210, February 1957. (In German) (Röntgen- und Radiumabteilung Knappschafts-Krankenhauses, Recklinghausen, Germany)

Whenever a recent pulmonary consolidation of a nonspecific nature fails to clear within a month, bronchography is of special diagnostic value, even more so than tomography. This procedure has proved to be without harm and, in some cases, has even had a beneficial therapeutic effect.

Altogether 32 cases were studied during a two-year period. Cases of marked bronchiectasis and the middle lobe syndrome were excluded as representing separate conditions. In the nonspecific consolidation there was always patency of the larger as well as of the smaller bronchial ramifications, with absence of a block or of pronounced bronchial narrowing. In 2 cases the bronchographic findings were normal, while in the remaining 30 some of the following changes could be observed: (1) bronchial dilatation and/or narrowing, (2) incomplete filling of smaller bronchial branches, (3) changes of bronchial walls, and (4) crowding or close approximation of bronchi.

In 3 cases there was involvement of an entire lobe or of two lobes, while in all others the consolidation was of the segmental type. Filling of bronchial subsegments was incomplete in 30 and changes of the bronchial wall were noted in 23 cases. Crowding of the bronchial tree, observed in 16 patients, suggested a shrinking process and interstitial fibrosis. Nevertheless, clearing of the consolidation was still observed in a few instances.

A so-called deforming bronchitis often leads to de-

layed resolution. This condition, however, is considered the underlying cause and not the result of a chronic pneumonitis. Bronchogenic carcinoma can be differentiated by presence of a block. In peripheral carcinoma, there is either bronchial shift in the adjacent segments or presence of several small blocks. Alveolar-cell carcinoma is occasionally difficult to differentiate bronchographically. In this condition there is absence of bronchiectasis but poor filling of the bronchial tree. Silicosis is characterized by incomplete filling and closure of the smaller bronchial branches.

Ten roentgenograms; 1 table.

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**Clarification of Angiographic Symptomatology in Pulmonary Tuberculosis.** Hh. Löhr, H. Scholtze, and W. Klinner. Fortschr. a. d. Geb. d. Röntgenstrahlen **86:** 192–203, February 1957. (In German) (Chirurgische Universitäts-Klinik, Marburg/Lahn, Germany)

Selective angiography of pulmonary lobes and segments has proved very helpful in tuberculosis, preoperatively. The procedure has revealed more extensive changes than could be suspected from ordinary roentgenograms, tomograms, and bronchograms. On the other hand, fairly normal angiograms have changed an original impression of an active lesion to an arrested process. Altogether, 150 cases of tuberculosis have been studied by this method. Additional information in this group has been obtained by spirometry, blood gas analysis, and pulmonary blood pressure determinations.

In the angiographic procedure, care has been taken that the tip of the catheter was lodged in a certain segmental artery and that the roentgen exposure was synchronized with the injection of the contrast material. The group of cases comprised caseous infiltration, isolated foci, fibrotic induration, chronic irreversible atelectasis, collapse, and pulmonary destruction.

The earliest vascular changes consist in rarefaction of the capillary branches. These terminate abruptly instead of tapering, as well as showing a sudden change of direction. When segmental arteries are rigid and devoid of branches, a complete induration can be assumed as the end-result of a specific process. Circulation is also slowed in such an area. Filling defects and breaking-off of larger vessels are seen at the margins of larger infiltrations. Such changes in close association with a tuberculoma, cavity or caseous dissemination denote complete destruction or displacement of vessels due to fibrotic reaction of their walls. In atelectasis these changes indicate an irreversible process. Partial absence of smaller branches and thinning of larger vessels, with spreading of existing branches, suggest emphysema. In collapse of a healthy lung there is only crowding of vessels. When an entire lobe shows vascular changes, such as rarefactions, thinning, skipped areas, distortion, cut-off appearance, lack of capillary filling, and spreading of smaller vessels, a total destruction of lung tissue can be assumed.

In 30 cases the findings could be completely reproduced and verified by angiograms of the surgical specimens.

Seven roentgenograms; 6 photomicrographs.

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## THE HEART AND BLOOD VESSELS

**Cardiac Physiology Revealed by the Roentgen Ray; Applications of Electrokymography, Biplane Angiocardiography and Cinefluorography.** Herbert M. Stauffer, Morton J. Oppenheimer, Louis A. Soloff, and George H. Stewart, III. Am. J. Roentgenol. **77:** 195–206, February 1957. (H. M. S., Temple University Hospital, Philadelphia 40, Penna.)

The authors review their experience with the following special technics for the study of cardiac function: kymography, angiocardiography, and roentgen cinematography.

The *electrokymograph* records, *via* photomultiplier tubes, the changes in roentgen-ray transmission due to variations in the thickness of the heart or movements of its border. Though highly accurate records are thus obtained, their proper interpretation remains difficult. It is believed that showing of the rate of early ventricular ejection as demonstrated by this method may be an important index of the functional status of the myocardium. The authors did not find that the electrokymogram of the left atrium in mitral regurgitation is pathognomonic.

For their *angiocardiographic studies,* the authors use the biplane stereoscopic apparatus devised by Chamberlain. They obtain anteroposterior and lateral views routinely and stress the value of two projections for identification of chambers and timing the appearance of contrast material. In mitral stenosis a disproportionate prolongation of the pulmonary artery time and the left atrial time was found. The findings fail to support the present dominant concept that left atrial changes are proportional to the degree of narrowing of the mitral orifice and to the duration of the obstruction. Similarly, there was no correlation between left atrial time or volume and right ventricular time, suggesting that the left atrial changes are not the immediate cause of right ventricular alteration.

Interest in the use of image intensification in *cinefluorographic angiocardiography* prompted an investigation of the persistence of light from commercially available intensifier output phosphors. Although the lag of the Philips intensifier tube was considerably longer than that of the Westinghouse, the initial drop in light intensity is so rapid that the prolonged persistence at light levels becomes of little practical photographic importance. Despite blurring of the contrast material on individual frames due to relatively long exposures, the quality of the image when viewed as a motion picture does not seem impaired.

Additional work has been done on the injection of carbon dioxide as an intracardiac contrast material. (For an earlier study see Stauffer *et al.:* Radiology **66:** 686, 1956) Up to 100 c.c. have been administered in adults. In animal studies it has been observed that the pulmonary and aortic valves become incompetent in the presence of the gas, probably because the eddy currents in the blood stream, which are thought to play a part in valvular closage, are disrupted. "Double contrast" studies of the left ventricle have been done with injection of Diodrast simultaneously or immediately before the injection of carbon dioxide. Cinefluorography has repeatedly shown mitral regurgitation of opaque contrast material following injection into the left ventricle *via* aortic catheter in dogs.

Five figures. HOWARD J. BARNHARD, M.D.
University of Arkansas Medical Center

**Cardiac Ventriculography; Direct Transthoracic Needle Puncture Opacification of the Left (or Right) Ventricle.** J. Stauffer Lehman, Benjamin G. Musser, and Harry D. Lykens. Am. J. Roentgenol. **77:** 207–234, February 1957. (J. S. L., Hahnemann Medical College and Hospital, Philadelphia 2, Penna.)

For direct ventricular opacification, the authors introduce a 6-inch short-bevel needle at the xiphoid area and continue it into the right ventricle of the heart or further into the left ventricle. The angulation is varied depending upon the estimated size of the ventricle and whether it be the right or left. Variations and precautions will not be detailed here, since anyone wishing to perform this maneuver should certainly read this excellent article in its entirety.

The method has been employed 77 times in 60 patients with inadvertent intramyocardial and intrapericardial infiltration of the opaque substance in 8 patients; most of these incidents took place when the patient drew a deep breath during the injection; all occurred during the first 47 examinations. The most serious result of intramyocardial injection was the development of complete heart block, which had persisted for four months at the time of writing. It is the authors' belief that in this case the existing mitral insufficiency was aggravated by the mechanical inefficiency resulting from this block.

The authors have not employed this procedure in infants or children and would be "extremely reluctant" to do so, as they believe the possibility of intramyocardial injection is much more likely with a small ventricular cavity.

Twenty-five roentgenograms; 6 electrocardiographic tracings; 2 photographs; 1 diagram; 3 tables.

HOWARD J. BARNHARD, M.D.
University of Arkansas Medical Center

**Angiocardiography as a Means of Early Diagnosis in Congenital Cardiopathies.** John Lind and Carl Wegelius. Arch. med. inf. (Habana) **24:** 177–198, 1955. (In Spanish) (C. W., Norrtulls Hospital, Stockholm 23, Sweden)

Infants with congenital malformations of the heart often die at an early age before a diagnosis is established. An accurate diagnosis can, however, be made even in early infancy. Surgical correction is frequently necessary and can be accomplished successfully in this age group. Considerably more intense examination of all suspected cases may well lead to increased possibilities for a correct diagnosis and thus for surgical aid. All the diagnostic methods now available must often be used to solve the diagnostic problem. Rapid biplane angiocardiography with simultaneous ECG marking is, according to the authors' experience, a valuable diagnostic procedure in infancy. This technic permits conclusions concerning function, thus, to a certain extent, going beyond the anatomical aspects of the problem and furnishing a perception of the pathophysiology of the heart work.

JAMES T. CASE, M.D.
Santa Barbara, Calif.

**The Value of Fast Angiocardiography in the Early Diagnosis of Patent Ductus Arteriosus.** J. Lind, M. Rocha, and C. Wegelius. Am. J. Roentgenol. **77:** 235–247, February 1957. (C. W., Norrtulls Hospital, Stockholm 23, Sweden).

In the absence of actual visualization of the open ductus arteriosus there are several indirect or secondary signs which more or less strongly suggest its presence: (1) aortic infundibular dilatation; (2) dilatation of the pulmonary artery; (3) elevation of the truncus—conus pulmonary artery and its left main branch; (4) increased pulmonary artery output and increased filling of the central pulmonary blood vessels; (5) dilution of the contrast medium in the pulmonary artery, best seen during ventricular diastole; (6) prolonged circulation of the contrast medium in the pulmonary vessels; (7) enlargement of the left atrium and ventricle; (8) refilling of the pulmonary artery in the later phase of angiocardiography.

The authors recommend a rapid exposure of three to four pairs of films synchronously in two planes per heart cycle, with simultaneous electrocardiographic registration and automatic exposure marking.

Thirty-four roentgenograms; 1 table.

HOWARD J. BARNHARD, M.D.
University of Arkansas Medical Center

**Roentgenologic Aspects of the Eisenmenger Complex.** Carl L. Ebnother and Herbert L. Abrams. Am. J. Roentgenol. **77:** 248–262, February 1957. (H. L. A., Stanford University School of Medicine, Clay and Webster Sts., San Francisco 15, Calif.)

The authors report a series of 12 cases of the Eisenmenger complex, summarizing the clinical data and existing pathologic and physiologic concepts, and describing the roentgen findings. The criteria for diagnosis were the presence of pulmonary and right ventricular hypertension, absence of pulmonic stenosis, evidence of a ventricular septal defect, and demonstration of a right-to-left shunt of blood from the right ventricle to the aorta.

From the roentgenologic standpoint, no correlation between overall heart size and pulmonary or systemic flow, pulmonary artery pressure, or pulmonary vascular resistance was definable. Right ventricular enlargement was a constant feature but varied in degree, with no specific correlation with the physiologic data. Neither left atrial nor left ventricular enlargement was a constant or striking finding. There was suggestive evidence of right atrial enlargement in two-thirds of the cases. The main pulmonary artery was enlarged in all cases, as were the central pulmonary arteries. The mid-zone branches of the pulmonary arteries were also consistently enlarged but less than in the presence of large left-to-right shunts. Peripheral branches were generally disproportionately small in relation to the caliber of the enlarged hilar vessels. The aorta appeared hypoplastic in 75 per cent of the cases.

Angiocardiography showed slight to moderate enlargement of the right atrium and ventricle, simultaneous opacification of the pulmonary artery and the aorta, and dilatation of the main pulmonary artery and its central branches.

The authors feel that it is significant that in severe pulmonary hypertension in congenital heart disease the peripheral arterial vessels are either of normal size or small in comparison to the main and hilar pulmonary arteries, while in patients with large left-to-right shunts and normal pressure the peripheral arteries show a commensurate increase in size with the main and hilar vessels.

Nineteen roentgenograms; 2 diagrams.

ELEANOR POLK-DEED, M.D.
University of Arkansas Medical Center

**The Angiocardiographic Patterns of Interatrial Septal Defect with Left to Right Flow.** Louis A. Soloff, Jacob Zatuchni, and Herbert M. Stauffer. Am. J. M. Sc. **233:** 167–175, February 1957. (Temple University School of Medicine, Philadelphia, Penna.)

Although cardiac catheterization is usually considered sufficient to make the diagnosis of uncomplicated septal defects with left-to right shunt, the authors point out that angiocardiography can demonstrate a characteristic pattern. Two cases of interatrial septal defect are presented, 1 of the ostium primum and 1 of the ostium secundum type. The use of the lateral position for maximum separation of the two atria is recommended.

The first finding is hazing of the posterior edge of the right atrium at its initial filling caused by mixing of unopacified blood entering from the left atrium through the defect. This sign is less constant than the second, the re-opacification of the right atrium after opacification of the left atrium. Prolonged opacification of vessels and chambers distal to the suspected shunt, in the presence of a short or normal intracardiac circulation time, is also usually indicative of a right-to-left shunt. If the atrial septal defect is of the ostium primum type, there may be demonstrated some right-to-left flow on the early films in the inferior portion of the left atrium and early opacification of the left ventricle.

Sixteen roentgenograms; 4 drawings; 2 graphs.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

**Angiocardiography in Mitral Disease. Preliminary Report.** H. Arvidsson and P. Ödman. Acta radiol. **47**: 97–118, February 1957. (Södersjukhuset, Stockholm, Sweden)

This discussion of angiocardiography begins with a history of its use in mitral disease. The authors' technic for visualization of the left side of the heart calls for (1) a two-plane film changer with which it is possible to obtain six pairs of pictures per second; (2) relatively large amounts of contrast material; (3) general anesthesia; (4) simultaneous electrocardiographic recordings. The medium is introduced by way of a catheter positioned in the pulmonary artery.

Observations were made on 25 cases of mitral disease diagnosed clinically. The findings in the pulmonary artery and its branches were the same as those recorded by earlier investigators. The central arteries were widened; at the level of the first division of the pulmonary arteries a sudden change in caliber occurred, the vessels being narrower than normal peripheral to that site; the peripheral vessels were tortuous and decreased in number. The left atrium, because of distention of its muscular walls by increased pressure, assumed an ellipsoid form. While exact volumetric determinations were impossible, cyclic volume changes of the atrium could be followed. The findings were in agreement with conceptions of the hemodynamics in mitral stenosis and insufficiency.

In uncomplicated mitral stenosis, changes in the pulmonary arteries showed a striking correlation with the degree of pulmonary hypertension. The degree of dilatation of the left atrium, however, could not be correlated with the pulmonary artery pressure or PCV pressure.

In mitral insufficiency the pulmonary arteries were in general normal or only slightly dilated; the pulmonary veins were more prominent. The left atrium was dilated in all cases and showed greater cyclic volume variations than in stenosis. In no case was a regurgitant jet noted.

One case of combined mitral stenosis and aortic insufficiency and one of combined mitral and aortic stenosis were observed. The aortic valve lesions were diagnosed by thoracic aortography.

The authors discuss the various types of angiography and some further points in the differential diagnosis between mitral insufficiency and stenosis. In view of the risks entailed, angiography should be used, they believe, only in those cases of mitral disease in which it might give significant information.

Thirteen roentgenograms; 4 diagrams.

LAWRENCE FETTERMAN, M.D.
Cleveland City Hospital

**The Roentgenologic Diagnosis of Pulmonary Hypertension in Mitral Stenosis.** John B. Schwedel, Doris W. Escher, Robert S. Aaron, and Dennison Young. Am. Heart J. **53:** 163–170, February 1957. (Montefiore Hospital, New York, N. Y.)

The authors studied 105 patients with mitral stenosis for roentgen evidence of pulmonary hypertension. They measured the width of the descending right pulmonary artery on a teleroentgenogram and sought to correlate this with the resting mean pulmonary pressures as determined in 77 cases by cardiac catheterization and in 56 at the time of surgery.

The width of the right descending pulmonary artery in 6-foot film projections normally ranges from 9 to 13 or 14 mm. Measurements in excess of 14 mm. are to be regarded as abnormal. The upper limit of normal mean pulmonary artery pressure is 15 mm. Hg. A mean pressure of 25 mm. or more is considered a significant elevation.

Of the 77 catheterized patients, 47 had right pulmonary arteries measuring 14 mm. or more. Forty-five of the 47 had resting mean pressures of 25 mm. Hg or more, and 2 had less significant elevation. In this group, 41 patients had pulmonary artery measurements of 15 mm. or more.

A similar correlation was observed between pulmonary artery widths and pulmonary artery pressures recorded at time of surgery. Thirty-four patients had pulmonary arteries at least 14 mm. wide, and 33 of this number had significant pressure elevations, 25 mm. or more. Twenty-seven had arteries of 15 mm. width or greater, and all of these showed significant pressure elevations.

The authors conclude that, in mitral stenosis, a descending right pulmonary artery 15 mm. or more in width is an indication of significant pulmonary hypertension; with an artery of 14 mm. width, significant hypertension is probably present. There is no linear correlation between the size of the pulmonary artery and the pulmonary pressure.

Eleven roentgenograms; 1 drawing; 2 graphs.

HENRY K. TAYLOR, M. D.
New York, N. Y.

**Right-Sided Aortic Arch: Report of Six Cases.** William F. Boyle and Christopher C. Shaw. New England J. Med. **256**: 392–395, Feb. 28, 1957. (Medical Dispensary, Philadelphia Naval Shipyard, Philadelphia, Penna.)

Normally, the aortic arch develops from the fourth

branchial anlage on the left side and assumes its usual position to the left of the vertebral column. Occasionally the origin is from the fourth branchial arch on the right side, and the aorta then arches to the right and may descend throughout its entire length to the right of the spinal column; more frequently it crosses over from the right to the left in the lower thoracic region and emerges in its normal position beneath the diaphragm. Usually this is a minor abnormality, since it does not fundamentally alter the circulation of the blood.

A right-sided aortic arch together with a right descending aorta may, however, be associated with a left-sided ligamentum arteriosum that circles, in whole or in part, the trachea and esophagus and thus produces a vascular ring. This ring may constrict the trachea and esophagus, producing symptoms of congenital stridor and dysphagia. This situation is readily amenable to surgery by division of the ligamentum arteriosum or patent ductus arteriosus. Right-sided aortic arch is present in about a fourth of the cases of tetralogy of Fallot and may be associated with other congenital anomalies, such as double aortic arch, pulmonary stenosis, tricuspid atresia, and dextrocardia.

The authors report 6 cases of right-sided aortic arch in persons ranging from twenty to seventy-four years of age—all asymptomatic—in the course of an annual chest survey program at a naval base, in which 20,505 photofluorograms were obtained. In this consecutive series no other anomalies of the heart and great vessels were encountered.

Right-sided aortic arch must not be confused with dextroposition of the aorta, in which the orifice of the aorta has moved to the right with partial overriding of the right ventricle and consequent admixture of venous and arterial blood. This produces profound circulatory embarrassment as frequently presented in the tetralogy of Fallot and in the Eisenmenger complex. Aortic dextroposition also occurs in the Taussig-Bing syndrome and in "pseudotruncus arteriosus."

Right-sided aortic arch should be considered in the differential diagnosis of superior mediastinal x-ray shadows produced by neoplasms, lymphadenopathy, aneurysm of the aorta, or malformation of the manubrium sterni. Diagnosis is established by means of the esophagogram, which shows indentation of the esophagus toward the right and anteriorly at the aortic arch level.

Three roentgenograms.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

**Calcification of the Ascending Aorta.** Bernard S. Epstein. Am. J. Roentgenol. **77:** 281–288, February 1957. (Long Island Jewish Hospital, 270-05 76th Ave., New Hyde Park, Long Island, N. Y.)

Observations on 20 cases of radiologically demonstrable calcification of the ascending aorta, without aneurysm, are reported. Eight cases were definitely syphilitic as indicated by positive serologic tests or a history of treatment for syphilis. In 5 of these the diameter of the ascending aorta, measured on a left anterior oblique or left lateral film at approximately its midpoint, was 5.0 to 5.5 cm.; in the other 3 it was 3.6 to 4.5 cm. Accompanying calcification of the transverse aorta (slight to extensive) was visible in 7 of the cases and of the descending thoracic aorta in 4.

Eight cases were considered possibly syphilitic, solely on the basis of the aortic calcification, advanced in 6, and mild in 2. In these cases there was no history of syphilis and serologic reactions were negative.

The remaining 4 patients, all examined at necropsy, showed no pathologic evidence of syphilis. One, with extensive calcification of the ascending aorta, had no calcification of the arch or descending portion.

In none of the 4 cases did the diameter of the ascending aorta exceed 4.0 cm.

While calcification of the ascending aorta is usually a manifestation of syphilis, a nonsyphilitic origin should be considered, especially when the diameter is within normal limits and when the patient is elderly.

Eight roentgenograms.

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**The Importance of Angiocardiography for Visualizing the Thoracic Aorta.** Israel Steinberg and Nathaniel Finby. Arch. Surg. **74:** 29–38, January 1957. (525 East 68th St., New York 21, N. Y.)

The authors reiterate the practicality of angiocardiography for aortic visualization. Aortography by left auricular, left ventricular, and aortic puncture and catheterization is more difficult, carries a greater risk, and should not be used routinely. Thirty-five to fifty cubic centimeters of contrast substance (Urokon sodium 70 per cent) injected into the arm vein within one and one-half seconds will nearly always demonstrate the adult aorta if films are exposed between seven and nine seconds after the beginning of the injection. The authors prefer the erect, left anterior oblique view, which visualizes the brachiocephalic vessels as well. Films may be exposed on the ordinary 14 × 17-inch stereo cassette changer.

When disease of the mediastinal structures, especially tumor, occurs, it is difficult if not impossible to distinguish it from the adjacent cardiovascular structures. In such instances, angiocardiography, by visualizing the cardiac chambers and great vessels, will readily make the distinction. Roentgenograms are reproduced showing a normal aorta well separated from a mediastinal mass.

Newer surgical technics for the repair of aneurysms now make the early diagnosis of such lesions more than a matter of academic interest. This can be accomplished readily by angiocardiography, without resort to aortic puncture or retrograde aortography. Illustrations showing the application of the procedure in syphilitic aneurysms, dissecting aneurysms, traumatic aneurysms of the thoracic aorta, and buckling of the brachiocephalic arteries are included.

Among the congenital lesions of the aorta which may be usually readily detected by angiocardiography are coarctation of the aorta, congenital aortic sinus aneurysms, pseudocoarctation, and patent ductus arteriosus with reversal of shunt, where opacification of the descending thoracic aorta is noted simultaneously with opacification of the pulmonary arteries.

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**Diagnosis of Arteriosclerotic Aneurysms of the Thoracic Aorta: Report of Six Cases.** Israel Steinberg. Ann. Int. Med. **46:** 218–246, February 1957. (525 East 68th St., New York 21, N. Y.)

Due to the decreasing incidence of tertiary syphilis and increased life expectancy, aneurysms of the thoracic

aorta are now more commonly due to arteriosclerosis than to syphilis. Arteriosclerosis tends to occur in the arch and descending portions of the aorta. This is in contrast to syphilis, where the ascending aorta and arch are usually involved.

Six cases of arteriosclerotic aneurysm of the thoracic aorta are reported. The age at which the diagnosis was first made ranged from fifty-one to seventy-seven years. Three patients gave a history of long-standing hypertension. Backache was the chief complaint of 2. One complained of hoarseness and another of hemoptysis. One patient was free of complaints referable to the thorax; weakness and unsteadiness in gait were attributed to advanced age.

All patients were ambulant and well nourished. Tortuous, sclerotic peripheral vessels were found in 2, and cardiac murmurs were present in 2. One was found to have paresis of the recurrent laryngeal nerve.

Electrocardiographic studies were normal in 2 cases; showed left axis deviation in 3 instances, right bundle branch block in 1, slight prolongation of P-R interval to 0.21 sec. in 1, and occasional premature beats in 1. None of the patients had electrocardiographic evidence of coronary artery occlusion or insufficiency.

Conventional roentgenography disclosed hilar or mediastinal masses and/or enlarged aortic shadows in every instance. Despite the aortic involvement, pulsation was recognized in only 1 patient. Fluoroscopy, however, was valuable for localization of the aneurysms. Study in the left anterior oblique position was especially useful in disclosing aortic unfolding, tortuosity, and dilatation. Calcification of the aortic wall and/or aneurysm occurred in 2 patients. Generalized aortic density, a sign of thickening and sclerosis, was observed twice in the descending aorta. Esophageal visualization proved valuable for estimating aortic tortuosity.

Special studies (tomography) were necessary to establish the presence of erosion of vertebral bodies in 1 instance. Films of the abdomen, especially lateral views, were important for the demonstration of calcium in the abdominal aorta.

Angiocardiography, by visualizing the thoracic aorta, provided the definitive diagnosis of aneurysm. In most instances the opacified ascending aorta appeared smooth, regular in outline, and normal or only slightly dilated. In contrast to syphilitic aortitis, the midportion of the ascending aorta was generally less than 38 mm. in diameter. Aneurysmal dilatations of the arch and descending portions were clearly demonstrated. Saccular, as well as fusiform aneurysms, were differentiated. Furthermore, thrombus within aneurysms explained the absence of pulsations. Finally, increased aortic wall thickness was well delineated.

Aortic aneurysms due to other causes should be differentiated from the syphilitic and arteriosclerotic types. *Congenital* aortic aneurysms are rare and usually occur in the young. A chronic *dissecting* aneurysm of the aorta may produce a markedly large vessel and, on angiocardiography, be recognized by the widespread narrowing of the aortic lumen. Congenital anomalies (kinking) of the aortic arch may simulate a mediastinal tumor and are easily differentiated from aneurysms by angiocardiography.

Excision of thoracic aortic aneurysms and replacement by a homograft have become generally accepted as the treatment of choice. Only one patient in the present series was treated surgically.

Too few arteriosclerotic aneurysms of the thoracic aorta diagnosed during life are available to estimate the prognosis accurately. Of the author's 6 patients, 3 had died: 1 died suddenly, presumably of aortic rupture; another died soon after diagnosis, following nailing of a fractured femur; the third death followed excision and homografting of thoracic and abdominal aneurysms. Of the 3 living patients, one was asymptomatic at the time of the report, despite the presence of two large fusiform aneurysms.

Twenty-three roentgenograms; 1 photograph.

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**Roentgen Manifestations of Unperforated Aortic Sinus Aneurysms. Report of Three New Cases.** Israel Steinberg and Nathaniel Finby. Am. J. Roentgenol. **77**: 263–273, February 1957. (I. S., 525 East 68th St., New York 21, N. Y.)

The authors report 3 cases of aneurysm of the aortic sinuses diagnosed during life, one of which was confirmed at autopsy. These bring to 20 the number of unperforated aortic sinus aneurysms recognized during life at the New York Hospital-Cornell Medical Center.

This rare condition is classified as either congenital or acquired, the acquired cases being due to syphilis or bacterial endocarditis. Dilatation of the aortic ring and the production of aortic insufficiency is the most common cause of death. Clinical features are nonspecific but congenital aneurysms are often associated with other cardiac anomalies. Roentgenography is necessary for diagnosis and classification.

Congenital aneurysms are believed to involve chiefly the right and noncoronary sinuses and are paper thin. Roentgenographic study usually shows marked enlargement of the cardiac silhouette and dilatation of the ascending aorta, involving the sinuses. Unusual pulsation of the root and ascending aorta may be seen fluoroscopically. Angiography is usually necessary to establish the diagnosis, particularly in view of the likelihood of associated anomalies.

Acquired aneurysms, usually syphilitic, may involve any of the three sinuses, and are large and thick-walled. Roentgenographically the heart is large and boot-shaped, with left ventricular enlargement due to aortic insufficiency. Fusiform or saccular aneurysms of the ascending aorta are frequent findings. Calcification may extend into the intracardiac origin of the aorta and outline the aortic sinuses, thus making diagnosis possible with conventional roentgenography.

The prognosis in unperforated aortic sinus aneurysms and the surgical attack on these and ruptured aneurysms are discussed.

Twelve roentgenograms; 1 photograph; 3 drawings.

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University of Arkansas Medical Center

**Roentgenographic Visualization of the Coronary Arteries.** Nathaniel E. Reich and Morris Witten. Am. J. Roentgenol. **77**: 274–280, February 1957. (N. E. R., 135 Eastern Parkway, Brooklyn 38, N. Y.)

It is well known that calcification of the coronary vessels is of common occurrence. In most instances, however, the deposits are not identifiable on roentgen films. Presumably the arteriosclerotic process must be advanced and rather dense to be demonstrable. Other considerations playing a definite role in roentgenographic recognition of coronary sclerosis are (1) aware-

ness of the common sites and characteristics of such densities, (2) roentgenograms of good technical quality in multiple projections, and (3) differentiation from other intra- and extracardiac densities.

The most common site of visible calcification is the circumflex branch of the left coronary artery. Next in frequency is the descending branch of the left coronary artery in the upper portion of the interventricular groove. Frequently both of these branches are calcified. Less frequently calcification may be seen in the right coronary artery.

Characteristically, the calcifications have the appearance of linear streaks and interrupted plaques arranged in parallel segments. Fluoroscopically the calcified vessels move synchronously with the adjacent heart border, but the movements are less dramatic than those of calcified valves and annulus fibrosus.

Six cases with roentgen evidence of sclerotic changes in branches of the left coronary artery were observed by the authors in patients ranging in age from fifty-six to seventy-six years. Five of the 6 patients presented normal electrocardiograms. Only 1 had suffered a coronary occlusion. Hypertension was present in 4. Cardiac symptoms were marked in only 2 instances. Clinical evidence of atheromatous degeneration was commonly manifest in the cerebral and other peripheral arteries.

Eight roentgenograms; 3 diagrams; 1 electrocardiogram; 1 table. JAMES R. BEARDEN, M.D.
University of Arkansas Medical Center

**Variations in the Origin of the Coronary Arteries in Man with Special Reference to the Accessory Branches.** A. Castellanos, Jr., F. Sala Panisello, J. D. Blair, and F. Valladares. Arch. de med. inf. (Habana) **24:** 152–162, 1955. (In Spanish)

In view of the different figures given by various authors for the incidence of anatomical variations and/or the existence of accessory coronary arteries, the authors studied the hearts of 65 children with the purpose of clarifying this subject. The following results were obtained:

(1) In 23 cases (35 per cent) the "arteria adiposa dextra" (conus artery) originated directly from the aorta.

(2) In 2 cases (3.1 per cent) 3 arteries had their origin from the right sinus of Valsalva: (*a*) the right coronary artery; (*b*) the "trunk" of the arteria adiposa dextra; (*c*) the "ascending" branch of the arteria adiposa dextra.

(3) In 1 case (1.5 per cent) there were also 3 arteries originating from the right sinus of Valsalva: (*a*) the artery of the sinus node; (*b*) the right coronary artery; (*c*) the arteria adiposa dextra.

(4) In 1 case (1.5 per cent) the left circumflex and the anterior descending arteries arose directly from the aorta. No trunk of the left coronary artery was observed as such.

(5) In 1 case (1.5 per cent) the ostium of the right coronary artery was located over the left sinus of Valsalva.

The authors conclude that the discrepancy which exists among different investigators is due to the fact that in some cases a careful search for these variations was made, and the hearts studied only for that purpose, while in others the findings were incidentally encountered in routine autopsies without employment of special or refined procedures. JAMES T. CASE, M.D.
Santa Barbara, Calif.

**The Radiological Diagnosis of Pulmonary Embolism.** Shirley Roberts. Proc. Roy. Soc. Med. **50:** 93–96, February 1957. (Radiodiagnostic Department, Royal Infirmary, Bristol, England)

The variability in appearance of pulmonary embolism on chest films is a reflection of the rather wide variety of pathological changes which may be associated. The clinical picture is similarly inconsistent, and for the same reason.

The branches of the pulmonary artery anastomose rather freely with the bronchial arteries proximal to the capillary bed. Consequently, even though a pulmonary artery may be occluded, the actual pathologic changes which take place distal to the occlusion depend upon the state of the anastomoses.

If infarction occurs, it may involve a whole lung, lobe, segment, or subsegment. Probably because ischemia is most complete distally along the involved vessel, radiographs usually show the lesion to be peripheral in location. About 75 per cent are in the lower lobes and they are often multiple.

Shape of the infarct shadow depends upon the projection in which it is viewed. The "typical" wedge is seen less commonly than a peripheral area of density with a rounded margin superiomedially or along its cardiac border.

Density depends upon the stage of the lesion or completeness of the infarction. Opacity may vary from a clearly defined density to vague clouding.

The time of appearance and duration of the shadow on the roentgenogram is variable. Early films often show no abnormality, but after two or three days large abnormalities may become apparent. Conversely, some lesions appear early and, if infarction is incomplete, may disappear rapidly.

In a few cases an early finding may be a zone of diminished vascular markings distal to the occlusion, evidently due to vasospasm. This may be followed either by a return to normal or by the appearance of an infarct shadow.

The size of the lesion and efficiency of the pulmonary circulation determine the rate of resolution or healing. Small or large fibrous scars often remain after complete healing, and it is not unusual, after large lesions, for loss of volume in the infarct area to occur with adjacent compensatory emphysema.

Associated pleural reaction occurs in less than half of the cases, usually shown by the presence of effusion. Residual localized pleural thickening may sometimes be seen after healing.

Six roentgenograms. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Pulmonary Stenosis with Closed Ventricular Septum.** M. Torner-Soler, J. Mª Morató-Portell, and I. Balaguer Vintró. Am. Heart J. **53:** 213–231, February 1957. (Cardio-Angiology School of the University of Barcelona, Barcelona, Spain)

There are two types of pulmonary stenosis with an intact interventricular septum: (1) with a patent foramen ovale or interatrial septal defect; (2) without an interatrial septal defect. These two groups have to be differentiated from the pulmonary stenoses with an overriding aorta, because of the difference in the corrective measures.

The authors studied 15 cases of pulmonary stenosis with an intact interventricular septum. In 7, no anomaly was demonstrated other than the pulmonary

stenosis. In 6, there were interatrial septal defects. One patient had a double superior vena cava with the left vena cava draining into the left auricle (a right-to-left shunt), and 1 had partial drainage of the pulmonary veins into the right auricle (a left-to-right shunt). In addition to the usual clinical, radiological, and electrocardiographic studies, ballistocardiographic tracings were obtained in 7 cases, and phonocardiographic tracings in 6. In 13, cardiac catheterization was done; in 7 angiocardiography was performed.

The most significant clinical feature is a loud systolic murmur accompanied by a thrill and a decrease or absence of the second pulmonic sound. The characteristic radiologic findings are cardiac enlargement, poststenotic dilatation of the pulmonary artery with increased pulsations, and decreased pulmonary vascularization. Angiocardiographic studies also revealed poststenotic dilatation of the main pulmonary artery and decreased pulmonary vascularization. Emptying of the right ventricle was delayed. In 3 cases there was early opacification of the left auricle due to a patent foramen ovale.

Cardiac catheterization reveals increased pressure in the right ventricle and a decreased pressure in the pulmonary artery.

Fourteen figures, including 8 roentgenograms; 6 tables.

HENRY K. TAYLOR, M.D.
New York, N. Y.

**Poststenotic Dilatation (Aneurysm) of the Subclavian Artery Associated with Cervical Rib: Report of Two Cases Visualized by Angiocardiography.** Israel Steinberg. New England J. Med. **256**: 242–244, Feb. 7, 1957. (Cornell University Medical College, New York, N. Y.)

In spite of the frequency of cervical ribs, reports of only 33 cases were found in which poststenotic dilatation of the subclavian artery was seen. [The explanation is probably that resection of the scalenus anticus muscle and removal of the cervical rib uniformly relieve whatever symptoms their presence causes, whether they result from pressure on the artery or the brachial plexus. Hence angiocardiography is not often included in the preoperative work-up of a patient with symptomatic cervical ribs.]

Of the author's 2 patients, 1 was forty years of age, with symptoms for six years, worse in the three weeks before admission. The other was only seven years old, with a sudden onset of pain in the neck after throwing a ball. Angiocardiography in each case demonstrated the poststenotic dilatation beyond the scalenus muscle. Surgery was curative in both instances.

Two roentgenograms; 1 drawing.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

**Roentgen Characteristics of the Arteria Lusoria.** J. Schmidt. Fortschr. a. d. Geb. d. Röntgenstrahlen **86**: 188–192, February 1957. (In German) (Medizinische Universitäts-Poliklinik Erlangen, Erlangen, Germany)

Tortuosity of the thoracic aorta usually suggests a hypertensive-arteriosclerotic or a senile condition. Occasionally, however, elongation of the aorta with a bulge of the aortic knob is seen in the younger age group without any clinical manifestations. When such an observation is made in the absence of symptoms, a vascular anomaly can be suspected. First consideration must be given to an aberrant subclavian artery, or *arteria lusoria*, which arises from the left aortic arch as the last separate vessel, with a frequency of 0.8 per cent. This artery traverses the posterior mediastinum in order to reach the right subclavicular area and, thereby, causes pressure on the esophagus.

The aortic knob is unusually high, and its descending portion turns from the left sharply back to the midline. Similar vascular anomalies, such as an aberrant right vertebral artery, an aberrant right common carotid artery, and an aberrant innominate artery are extremely rare but also show a prominent aortic knob and cause the same pressure band on the barium-filled esophagus. Although the esophageal pressure sign is characteristic of a vascular anomaly, diagnosis of a specific aberrant artery cannot be made without the aid of angiography or aortography.

Another valuable sign is an actual visualization of the arteria lusoria as a vascular shadow which can be followed from the aortic arch obliquely upward across the trachea to the right of the midline. This density is an upward continuation of the oblique impression of the barium-filled esophagus. Since it is projected into the spine, special scrutiny is necessary for its recognition. The left subclavian artery, on the other hand, is seen more easily at the same level due to its left paravertebral location.

Altogether, the author has seen an arteria lusoria in 34 cases. In only 1 of these was the aberrant vessel between the trachea and the esophagus instead of posterior to the esophagus.

Five roentgenograms.

ERNEST KRAFT, M.D.
Northport, N. Y.

**The Arteries of the Abdomen, Pelvis, and Thigh. I. Normal Roentgenographic Anatomy. II. Collateral Circulation in Obstructive Arterial Disease.** Robert F. Muller and Melvin M. Figley. Am. J. Roentgenol. **77**: 296–311, February 1957. (M. M. F., Department of Radiology, University Hospital, Ann Arbor, Mich.)

*I. Normal Roentgenographic Anatomy:* The roentgenographic anatomy of the arteries of the abdomen, pelvis, and thigh as demonstrated on 182 translumbar aortograms was studied. Representative aortograms and diagrams are presented. Virtually every named artery of the abdomen and pelvis was identified, but the identification of certain arteries is not possible at all times because of incomplete filling and superimposition of vessels. Anatomic variations were not observed as frequently as reported in anatomy texts. This may be because most of such variations occur at the sites of origin of the main arteries, where roentgenographic identification is least accurate.

*II. Collateral Circulation in Obstructive Arterial Disease:* Preoperative aortography is important in obstructive arterial disease for determination of the level and extent of the arterial block, the status of the adjacent main channel vessels, and the adequacy and distribution of collateral circulation. At times the bowel or extremity is supplied principally by a single collateral, the surgical sacrifice of which could be disastrous.

Aortographic study of 151 arterial obstructions in 91 patients confirmed previous anatomic descriptions of collateral channels, which are illustrated by representative roentgenograms. Around an arterial block in the abdomen and pelvis, collaterals may form from one of three sources: (1) anastomoses between segmental and

parietal arteries on the same side of the body (including intercostal, lumbar, inferior epigastric, and deep circumflex iliac arteries), (2) anastomoses between visceral arteries including superior and inferior mesenteric and visceral branches of the hypogastric artery, and (3) anastomoses across the midline between branches of the hypogastric arteries.

Sixteen roentgenograms; 3 drawings.

CAPT. GARTH R. DREWRY
Tampa, Fla.

**Phlebographic Study of the Superior Vena Cava.** Raúl Cicero and José Kuthy. Am. J. Roentgenol. **77**: 289–295, February 1957. (R. C., Unidad de Neumología, Pab. 27, Hospital General, Mexico 7, D. F., Mexico)

The authors reviewed 1,224 angiograms with reference to changes in the superior vena cava. These may be divided into 3 main groups, congenital variations (*e.g.*, absence or stenosis), changes in position, and obstruction.

The normal superior vena cava lies near the right border of the vertebral column. In cases of pulmonary or pleural fibrosis or tumor, it shifts with the mediastinum.

Obstruction may be due to formation of scar tissue following prolonged radiation therapy, compression by superior mediastinal masses (*e.g.*, aneurysm, dermoid cyst, enlarged lymph nodes), invasion by tumor (most often bronchogenic carcinoma), and rarely thrombosis. In cases of bronchogenic carcinoma of the right upper lobe, a polypoid mass within the vessel or slight narrowing in caliber of the superior vena cava is said to indicate inoperability. In cases of slowly progressive obstruction, an extensive collateral circulation develops *via* the thoracic wall veins, the azygos system, and the internal mammary veins.

Thirteen roentgenograms.

CAPT. GARTH R. DREWRY
Tampa, Fla.

**The Strain Obstruction Syndrome of the Femoral Vein.** Åke Gullmo. Acta radiol. **47**: 119–137, February 1957. (University Clinics of Lund, Lund, Sweden)

The "strain obstruction syndrome" of the femoral vein consists of a blocking of the vein in the lacuna vasorum, during strain, by hernial protrusions. The author tests for it by injecting the veins in the inguinal region while the patient, in the supine position, is straining. This forces the medium into any dilated and incompetent veins, which in the supine position are fairly empty.

The majority of normal subjects examined showed no change in the appearance of the femoral veins, though in some there was slight lateral displacement and 2 out of 30 showed valvular occlusion. Of 370 legs of patients with venous disorders, 60 per cent showed a tendency to strain obstruction and in 27 per cent there was complete compression. The author feels that laxity of the inguina may result in strain obstruction of the femoral vein, which in turn initiates a vicious circle of venous disorders of the leg. The syndrome is shown to be the usual cause of recurrence after high saphenous resections, and may cause spontaneous bleeding in the leg.

Thirty-six roentgenograms; 1 diagram; 1 table.

LAWRENCE FETTERMAN, M.D.
Cleveland City Hospital

**Percutaneous Splenoportal Venography Utilizing Rapid Serial Roentgenography.** John A. Evans and Ward D. O'Sullivan. Am. J. Roentgenol. **77**: 312–323, February 1957. (J. A. E., 525 East 68th St., New York 21, N. Y.)

Disadvantages of operative portal venography include restriction of the procedure to the operating room, surgical limitations in the choice of incision, and incomplete opacification of the portal venous system. Percutaneous portal venography, on the other hand, is a simple and safe method and provides an excellent means of vizualizing the portal system.

The technic of the procedure is set forth in detail. Fifty cubic centimeters of 70 per cent Urokon is injected through the ninth or tenth intercostal space into the spleen over a period of five to six seconds. Serial films made at one-second intervals for twelve to fifteen exposures completely delineate the portal system. The diagnostic quality of the study is chiefly dependent upon the expertness of the splenic puncture.

Percutaneous splenoportal venograms were obtained in 36 cirrhotic patients with portal hypertension, 6 patients having extrahepatic obstruction, and 2 with splenomegaly secondary to blood dyscrasia. In each examination valuable preoperative information about the portal system was obtained. Neither immediate nor delayed complications were encountered. Interesting features of representative cases are discussed. The authors emphasize that the phenomenon of nonopacification of the jet stream from the mouth of the superior mesenteric vein and the lack of opacification of the superior mesenteric vein itself are normal findings.

Twenty-six roentgenograms; 2 photographs; 5 drawings.

RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

**Roentgenologic Findings in Splenic Portography.** André J. Bruwer and George A. Hallenbeck. Am. J. Roentgenol. **77**: 324–331, February 1957. (A. J. B., Mayo Clinic, Rochester, Minn.)

Percutaneous splenic portography is a simpler method of opacifying the portal venous system prior to a shunt operation than operative portal portography. A review of the literature indicates that several hundred splenic portograms have been made, with no reported deaths, though there have been 3 cases of splenic rupture and 1 case of shock as complications. The authors do splenic portography only in cases in which operation is planned for the same day, the procedure being performed by the surgeon after the patient is on the operating table, under general anesthesia. An 18-gauge needle attached to a 50 ml. syringe by way of a short length of flexible plastic tubing is passed into the splenic pulp through the ninth intercostal space, in the midaxillary line. In the average adult, about 40 ml. of acetrizoate (Urokon Sodium) is injected as rapidly as possible (four or five seconds) and a roentgenogram is taken at the end of the injection. Immediate development of the film furnishes the surgeon with the information regarding the status of the vessels which he will be using for the shunt procedure. (The authors note their intention to change to a multiple-film technic as soon as possible.) The series reported here numbered 42 cases.

In the normal subject the opaque material begins to leave the spleen immediately, most of it being carried

away in four to five seconds. There is normally no evidence of reflux filling of the tributary veins. Abnormality is indicated by retrograde flow of the medium into the tributary vessels, especially the left gastric and the inferior mesenteric veins, and evidence of stasis in the portal vein. Nine illustrative cases are reported in detail.

Ten roentgenograms.

RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

## THE DIGESTIVE SYSTEM

**Roentgen Differential Diagnosis of Lesions Affecting the Esophagus.** R. Vincent Grieco and Noel F. Bartone. Am. J. Surg. **93:** 163–182, February 1957. (Methodist Hospital, Brooklyn, N. Y.)

An extensive description of the intrinsic and extrinsic lesions affecting the esophagus is presented. Numerous drawings and roentgenograms are used to illustrate the differential diagnosis, particularly with relation to carcinoma, achalasia, and disease of the fundus involving the esophagus.

The authors discuss at some length the difficulties inherent in the diagnosis of hiatus hernia and shortening of the esophagus, and point out that numerous workers have shown that the usual case of relatively short esophagus is the result of protracted reflux esophagitis with ensuing fibrosis and contraction.

Twenty-two roentgenograms; 3 sets of drawings with charts; 2 tables.

FRANK T. MORAN, M.D.
Auburn, N. Y.

**Carcinoma of the Esophagus.** William L. Watson and John T. Goodner. Am. J. Surg. **93:** 259–265, February 1957. (Memorial Center for Cancer and Allied Diseases, New York, N. Y.)

A discussion is given based on the study of a total of 1,756 patients with carcinoma of the esophagus seen at Memorial Hospital, New York City.

No specific etiology, of course, was found, but there appear to be numerous definite factors predisposing to esophageal cancer. These include bad teeth and ill-fitting dentures, making it necessary for the esophagus to handle large masses of incompletely masticated food; frequent drinking of large quantities of a very hot beverage such as tea; excessive use of alcohol, spiced foods, and tobacco; and leukoplakia.

It has been shown that esophageal cancer can be missed, and the authors emphasize the importance of esophagoscopy for an early and accurate diagnosis. Although complicated apparatus, difficult x-ray technics, and various opaque mixtures have been developed to make early roentgen recognition possible, these appear to have lost their popularity to some extent because of the more satisfactory results obtained with esophagoscopy.

The routine diagnostic procedure at Memorial Hospital (New York) during the investigation of a patient suspected of having carcinoma of the esophagus includes fluoroscopy, barium swallow, and x-ray films of the esophagus and lungs, with endoscopy the following day.

Fluoroscopy is essential to determine the size, shape, outline, and position of the lesion, as well as the size and shape of the lumen above and below the obstruction. This information is of the utmost value in determining the form of treatment to be instituted. Endoscopy should be performed by the surgeon who will direct the future therapeutic management of the patient.

Since the majority of patients seen at Memorial Hospital with cancer of the esophagus are in the advanced stage of the disease, radiotherapy with or without supportive surgical measures has been most frequently used. Careful planning of multiple portals to cross-fire the area is necessary. Four portals are commonly employed, two anterior and two posterior. Since cancer of the esophagus spreads longitudinally by way of the submucosal lymphatics, skin portals smaller than 14 × 7 cm. are seldom used.

Intraesophageal radium therapy was given in a group of patients having preliminary gastrostomy, but in no case was the cancer completely eradicated. Gold-filtered radon seeds have been inserted at periodic intervals through the esophagoscope. There is a tendency to "melt" the cancer within a zone of 1 cm. of their application, but excessive tumor slough, perforation, and mediastinitis have been encountered.

The surgical management of esophageal cancer depends on the segment of the organ (cervical, mid-thoracic, or cardiac) involved. Intrathoracic esophageal cancer requires removal of a longer portion. Total esophagectomy has been performed for this condition.

The end-results in the last 1,250 consecutive cases show only 12 survivals for five years or longer, regardless of type of treatment.

Three figures; 2 tables.

FRANK T. MORAN, M.D.
Auburn, N. Y.

**Congenital True Esophageal Diverticulum: Report of a Case Unassociated with Other Esophagotracheal Abnormality.** Arthur R. Nelson. Ann. Surg. **145:** 258–264, February 1957. (805 Lomax St., Jacksonville 5, Fla.)

The author reports a congenital diverticulum of the esophagus in a two-year-old girl, unassociated with the cricopharyngeal mechanism, or with esophageal stenosis, tracheal communication, or other apparent esophageal abnormality. This is believed to be the second proved case of a true diverticulum of congenital origin containing all layers of the esophagus to be recorded in the literature. (For the first such case, see Jackson and Shallow: Ann. Surg. **83:** 1, 1926.)

The diverticulum arose at the level of T-1, much lower than the site for cricopharyngeal and hypopharyngeal pouches and higher than the traction diverticula seen usually at the level of the carina. The neck of the diverticulum was wide, and the pouch extended anteriorly from the esophagus to impress the trachea. Partial excision and endoscopic dilatation produced a satisfactory functional result.

A brief survey of the literature dealing with esophageal abnormalities, congenital and acquired, is presented.

Four roentgenograms; 1 microphotograph.

SAUL SCHEFF, M.D.
Boston, Mass.

**Pharyngoesophageal Diverticulum.** Kenneth W. Warren. Am. J. Surg. **93:** 205–217, February 1957. (Department of Surgery, Lahey Clinic, Boston, Mass.)

The exact etiology of pulsion diverticula of the pharyngoesophagus is not known. It is believed, however, that a peristaltic wave is initiated during the act of swallowing, by the pharyngeal constrictors, be-

ginning in the nasopharynx, passing downward, and ending in the pharyngoesophageal junction. Anatomically, the lowest inferior constrictors and cricopharyngeal fibers are disposed obliquely at the pharyngoesophageal junction, thus producing a weak spot in a small triangular area at this point. Any undue pressure at this point, such as persistent lack of coordinated relaxation of the cricopharyngeal sphincter, may lead to a bulge and subsequent esophageal diverticulum.

The diagnosis is made by roentgen studies following the oral administration of barium. Experience at the Lahey Clinic indicates that esophagoscopy is not only unnecessary, but ill-advised unless it can be performed by an experienced endoscopist.

In the roentgen study, the anteroposterior view alone is not enough; a lateral view of the diverticulum should always be obtained. A characteristic spill-over from its top will differentiate it from an esophageal web. The contour of the diverticulum should be carefully studied and any irregularity should raise suspicion as to the possible presence of a malignant tumor.

The surgical treatment of pulsion diverticulum of the esophagus has gone through many phases, the early ones including establishment of an external fistula for emptying, excision, invagination, and diverticulopexy. These were accompanied by a high mortality and high recurrence rate. The first two-stage operation was performed by Goldmann in 1909 and was used successfully for many years at the Lahey Clinic. In a series of 365 cases reported by Lahey and Warren in 1954 there were only two deaths. More recently, however, the one-stage operation has been gaining favor. It is the opinion of the author that in the hands of surgeons with wide experience in esophageal surgery, large series of cases thus treated will show mortality, morbidity, and recurrence rates comparable to those with the two-stage procedure, and that the one-stage excision will become more and more popular.

Eight figures, including 3 roentgenograms.

FRANK T. MORAN, M.D.
Auburn, N. Y.

**The "V Sign" in the Diagnosis of Spontaneous Rupture of the Esophagus (An Early Roentgen Clue).** Emil A. Naclerio. Am. J. Surg. **93:** 291–298, February 1957. (Harlem Hospital, New York, N. Y.)

Spontaneous rupture of the esophagus is accompanied by a high mortality rate. The successful treatment depends on early diagnosis.

The principal diagnostic sign, and one which is most commonly present, is subcutaneous emphysema, often first noted in the left supraclavicular area. Early roentgenograms show mediastinal and/or subcutaneous emphysema, hydrothorax, or hydropneumothorax. Since the roentgen configuration takes the form of a V, it is referred to as the "V sign." If this roentgen sign arouses suspicion of esophageal rupture, the diagnosis can be confirmed and immediate surgery performed. The diagnosis can be further established by demonstrating extravasation of a swallow of Lipiodol into the mediastinum or pleural cavity.

Treatment should be aimed at wide excision of the mediastinum, direct repair of the site of rupture, expansion of the lung, and drainage of the pleural cavity.

Two case reports are used to illustrate the discussion.

Six roentgenograms; 2 photographs; 3 diagrams.

FRANK T. MORAN, M.D.
Auburn, N. Y.

**Dumping Syndrome: An Evaluation of Some Current Etiologic Concepts.** Banice M. Webber, Merrill A. Bender, and George E. Moore. New England J. Med. **256:** 285–289, Feb. 14, 1957. (B. M. W., Miriam Hospital, Providence, R. I.)

An attempt was made to determine the possible role of fall in plasma volume and a drop in serum potassium in the production of the dumping syndrome following subtotal or total gastrectomy. Observations were made on 16 postgastrectomy patients, of whom 8 gave a history of symptoms indicative of "dumping." The remaining 8 served as controls. The interval since surgery was from seven days to seven years.

The authors first confirmed the fact that ingestion of hypertonic glucose will reproduce the symptoms of dumping in those with the syndrome. The controls had no symptoms from the hypertonic glucose.

Serum potassium and plasma volume studies were made in both groups. Both values did indeed fall, but not enough in the opinion of the authors to produce the symptoms, nor at the proper time. Also it was found that the values in the controls showed essentially the same range of fluctuation, which therefore merely represented the altered physiology due to the altered anatomy attendant upon gastrectomy.

The unstated conclusion is that the etiology of the dumping syndrome is still unknown.

Three tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

**The Syndrome of Gastroduodenal Disease Associated with Chronic Cor Pulmonale.** Zalman Plotkin. Dis. of Chest **31:** 195–206, February 1957. (Beverly Hills, Calif.)

Because of the finding of unsuspected bleeding ulcers at autopsy in an individual who was hospitalized with a diagnosis of pulmonary emphysema and decompensated cor pulmonale, a study has been made of the coincidence of these conditions.

In 65 cases of pulmonary emphysema and chronic cor pulmonale seen postmortem, gastroduodenal disease was found in 27: gastric ulcers in 10, duodenal ulcers in 11, and hypertrophic gastritis in 6. The gastric ulcers were mostly on the posterior wall of the lesser curvature close to the prepyloric region. Seven of the 27 patients died from massive hemorrhage, and 2 from hemorrhage and perforation.

A comparison study was made of patients on the medical wards and domiciliary members who had pulmonary emphysema and cor pulmonale. Sixty-five persons were studied roentgenographically. Seven had gastric ulcers, 10 had duodenal ulcers, and 5 had ulcers of both types. Twenty-eight cases showed minimal to marked hypertrophic gastritis. In 14 of the group the x-ray findings were negative. In only a few of the 51 cases with positive findings would x-ray studies have been considered warranted on the basis of the clinical picture.

These observations indicate that the incidence of gastroduodenal disease is considerably higher in individuals with emphysema and cor pulmonale than in the average normal population. It is advised that all patients with these pulmonary conditions be subjected to roentgen study and, if necessary, gastroscopic examination of the stomach and duodenum.

Eight case histories are included.

Four roentgenograms.

HENRY K. TAYLOR, M.D.
New York, N. Y.

**Primary Malignant Neoplasms of the Duodenum. Discussion Based on Seventeen Cases, with Emphasis on Radiologic Diagnosis.** Seymour Ochsner and Martin S. Kleckner, Jr. J.A.M.A. **163:** 413–417, Feb. 9, 1957. (S. O., 3503 Prytania St., New Orleans 15, La.)

The authors have studied 17 cases of primary malignant tumors of the duodenum seen at the Ochsner Clinic and Charity Hospital in New Orleans between 1936 and 1955. Most of the patient were in the sixth or seventh decade. Fourteen of the tumors were adenocarcinomas, which is in accord with the predominance of this type reported in other series. Of the remaining cases, 2 were leiomyosarcomas and 1 a reticulosarcoma.

Three groups are recognized on the basis of location, each characterized by a particular symptom complex: (1) suprapapillary growths, producing symptoms principally of pyloric obstruction; (2) peripapillary lesions (involving the ampulla of Vater), with obstructive jaundice; (3) infrapapillary tumors manifested by gastrointestinal hemorrhage.

Great stress is laid on the roentgen examination in these cases. Despite certain factors that tend to obscure or confuse the diagnosis, "roentgenologic examination is the only method, with the exception of surgical exploration, by which a diagnosis is likely to be made." The following criteria are discussed: alteration in the mucosal pattern, intraluminal filling defect, altered contour and flexibility, ulceration, narrowing of the lumen by eccentric encroachment of the tumor or by annular growth, a paraduodenal mass. Perforation is indicated by free air in the peritoneal cavity. Effects of obstruction are the same as elsewhere in the gastrointestinal tract.

Differential diagnosis is concerned chiefly with chronic duodenal ulceration with deformity or stenosis, pancreatic tumors, congenital or postoperative adhesions, and benign duodenal tumors.

Primary excision is desirable when possible. Radiation is likely to have a beneficial effect only in the rare lymphoblastic type of growth.

Four roentgenograms. B. J. HILL, M.D.
University of Michigan

**Mucosa of the Duodenal Bulb. Method for Roentgenological Study.** George Levene and S. A. Kaufman. Am. J. Digest. Dis. **2:** 68–73, February 1957. (Massachusetts Memorial Hospitals, Boston 18, Mass.)

This brief presentation describes a method for radiographic study of the mucosa of the duodenal bulb. The procedure is a variation of the Hampton maneuver (Am. J. Roentgenol. **38:** 565, 1937). Following one or two initial swallows of barium mixture, the patient is placed on the table in the prone position. He is then turned on his left side and the right hip is rotated toward the table under fluoroscopic guidance so that gas present in the stomach rises to distend the duodenal bulb, which is uppermost.

It is stated by the authors that the method has great value in distinguishing active ulcers from scars of healed ulcers. Spot films are especially good in this position, because of proximity of the duodenum to the film.

Seven roentgenograms; 2 drawings.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Ileocolic Fistula of Appendiceal Origin.** Elliott S. Hurwitt and Walter Lentino. Ann. Surg. **145:** 275–278, February 1957. (Montefiore Hospital, New York, N. Y.)

Ileocolic fistulas usually occur as a result of regional enteritis, diverticulitis of the sigmoid colon, colonic carcinoma, lymphoma, granuloma, or foreign bodies. On the other hand, perforation of the appendix complicating acute appendicitis commonly leads to a generalized peritonitis or a localized abscess. The abscess may regress, require drainage, or spontaneously rupture in the general peritoneal cavity or into the rectum.

The authors present the case of a 56-year-old male who had apparently suffered a ruptured appendix some thirty years previously. The current study was negative except for barium examinations by enema and meal. These showed an amorphous collection of barium in the lower abdomen filling from the sigmoid by enema and leading to the ileum, which in turn led to the distorted cecum by an aberrant course lateral to the ascending colon.

At operation a wide resection of ileum was performed. The tip of the appendix had perforated the ileum, which was dilated, to form a large sac, apparent on the roentgenogram. This segment of devitalized small intestine communicated, by way of a fistula, with the lower sigmoid.

It is believed that this case represents the first appendico-ileocolic fistula to be reported.

Three roentgenograms; 3 drawings.

SAUL SCHEFF, M.D.
Boston, Mass.

**Gas Abscess of Pancreas.** Benjamin Felson. J.A.M.A. **163:** 637–641, Feb. 23, 1957. (University of Cincinnati College of Medicine, Cincinnati, Ohio)

During the past eight years 6 cases of gas-containing abscesses of the pancreas have been observed in the Cincinnati (Ohio) area. General clinical and laboratory findings in each instance have been those referable to acute pancreatitis without distinguishing features to indicate a gas abscess. Although none of the patients was a known diabetic prior to the acute episode, all showed glycosuria and hyperglycemia at some time during their acute illness. In all 6 cases the roentgen findings were felt to be highly characteristic, if not pathognomonic, of the disease under discussion. Each showed myriads of gas bubbles of mottled appearance overlying major portions of the pancreas usually best seen on simple anteroposterior and lateral views of the upper abdomen. Lateral views made with barium in the stomach localized the process best. Frequently there was displacement or impression of adjacent portions of the gastrointestinal tract. Obliteration or distortion of left renal and psoas shadows may also be observed. It is stressed that the typical gas pattern may not be manifest until several days after onset of the acute disease.

The appearance of the small gas bubbles in the region of the pancreas closely simulates that of feces in the transverse colon, or occasionally food particles in a distended stomach, so that these two conditions must be excluded. Once pancreatic disease is suspected, localization of the abscess is usually readily accomplished by appropriate simple filming or contrast examination. Occasionally a dilated "sentinel loop" will be recognized. Other conditions to be differentiated include

perforations of the hollow viscera resulting from various causes, with formation of walled-off abscess.

All of the reported cases were verified by postmortem or operative studies and in no instance was direct communication between the intestine and the necrotic pancreas shown. It is presumed, therefore, that the gas bubbles arise from bacterial action on substances, probably glucose, in the pancreatic tissues. The prognosis is grave, with a fatal outcome in 4 of the 6 cases reported here.

Eight roentgenograms. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

**Cholecystography and Cholangiography. Comparative Study of Various Methods and Their Relative Diagnostic Value in Hepatobiliary Diseases.** Carl P. Steglich and Harry J. Perlberg. Am. J. Digest. Dis. **2**: 50–67, February; 98–109, March 1957. (Jersey City Medical Center, Jersey City, N. J.)

In the first portion of this two-part article the various radiographic approaches to diagnosis in hepatobiliary disease are compared and evaluated. A total of 52 patients were studied. Varying combinations of oral Telepaque studies, intravenous Cholografin studies, and T-tube iodochloral cholangiograms were employed.

In 29 patients, both oral and intravenous cholecystography was performed, and the conclusion was reached that the intravenous method was more informative. The main difference between the two methods was the better visualization of the biliary tree with Cholografin.

In 15 patients whose gallbladders had been removed, Cholografin chlorangiography was performed. In 5 cases both Cholografin examinations and retrograde cholangiography with iodochloral were performed. In general, the radiographic appearances with the two methods were alike. However, visualization of the ducts was better with the retrograde method, whereas the intravenous method was thought to reflect more accurately the ability of the liver to excrete the medium.

The second portion of the presentation is devoted to the relationship between radiographic findings and liver disease or liver function. Discussion is based upon 27 patients with liver disease in whom cholecystography and cholangiography were performed.

There was definite correlation between radiographic and clinical findings in these patients. Those with decompensated, advanced hepatic disease showed poor, delayed, or no visualization of the biliary tree or the gallbladder. In those with subclinical disease visualization was good. Biochemical and histopathological studies also showed reasonably good correlation with the excretion of the opaque medium from the liver. Excretory cholecystography and cholangiography, except in advanced liver disease, appear to be unreliable liver function tests. Visualization in the presence of jaundice was found to depend upon the severity of the liver condition or upon the duration and intensity of an obstruction which might be present.

Six roentgenograms; 7 drawings; 5 tables.
DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Routine Operative Cholangiography.** J. L. Smoot and C. V. Cimmino. Virginia M. Monthly **84**: 71–75, February 1957. (Mary Washington Hospital, Fredericksburg, Va.)

This discussion of routine operative cholangiography, presented before a state medical society, takes up the advantages of this procedure and its rightful place in surgery of the gallbladder and bile ducts. Operative cholangiography calls attention to any anatomic aberrations of the biliary tract, demonstrates stones which could not otherwise be detected, brings to light the etiology of strictures, and makes it possible to avoid mistakes of a catastrophic nature. The examination has done much to transform surgery of the biliary system from a haphazard to a much more exact procedure. The inadequacies of the method are also listed.

Nine roentgenograms; 1 photograph.

## THE MUSCULOSKELETAL SYSTEM

**Osseous Phlebography.** Howard L. Steinbach, Floyd Jergesen, Rutherford S. Gilfillan, and Nicholas L. Petrakis. Surg., Gynec. & Obst. **104**: 215–226, February 1957. (University of California School of Medicine, San Francisco, Calif.)

The osseous venous system and the deep veins that drain it can be demonstrated by the injection of 10 to 20 c.c. of 50 per cent Hypaque into the appropriate bone through a No. 15 bone marrow needle. Because severe pain occasionally occurs at the time of injection, the procedure is done under a short general anesthesia.

The method may be used to study both normal and abnormal bone. In normal growing bone it can be shown that there is no venous connection across the epiphyseal plate but, once growth ceases, vascular channels do cross this area. Discontinuity is produced by fractures, and months may pass before the normal channels are reconstituted.

Abnormally slow clearance of the contrast material results when the medium is injected into the femoral head in aseptic necrosis of that structure, thereby demonstrating the vascular derangement. Delayed clearance has also been demonstrated in several cases of myelogenous leukemia following injections into various bones.

Inserting the needle deep into the medullary cavity of the bone often allows one to fill the central medullary veins. Studies of bone tumors by this method have shown both obstructive phenomenon, with dilatation of the veins and delay in drainage, and increased tumor circulation, with large venous channels and rapid drainage.

Injection more superficially into cancellous bone, particularly at the diaphysis of long bones, is followed by rapid drainage into the deep veins of the area. Thus, injection into the long bones of the extremities can be used to study varicosities and obstructive conditions. This method can be used when direct injection of the superficial veins is not possible because of edema and ulceration. It is also more physiologic, as both the deep and superficial veins are filled in normal fashion and success in filling the deep veins is more common.

By injecting various parts of the pelvic girdle, branches of the iliac veins have been visualized. Patients with osteitis pubis have been shown to have large tortuous veins around the symphysis, suggesting that thrombosis with secondary infection is an etiologic factor in this condition.

By injection of contrast material into the vertebral spinous processes, the internal vertebral veins can be filled, permitting study of intraspinal pathology. The material will also drain into the paravertebral veins filling the lumbar or azygos system. Demonstration of

the azygos veins by this means, combined with a demonstration of the internal mammary veins by injection into the sternum, allows both an anterior and posterior approach to the study of mediastinal masses.

Twenty-eight roentgenograms.

LESLIE M. ZATZ, M.D.
University of Pennsylvania

**Pseudohypoparathyroidism.** T. W. Howat and G. M. Ashurst. J. Bone & Joint Surg. **39-B:** 39–44, February 1957. (T. W. H., Western Infirmary, Glasgow, Scotland)

Pseudohypoparathyroidism is a rare condition in which there is a normal supply of parathyroid hormone but inability of the kidneys and bones to respond to this hormone in normal fashion. The authors report a case in a 21-year-old male who was retarded both mentally and physically, with a history of intermittent relatively minor convulsions. The lack of growth was most marked in the trunk. The hands and feet were short and stubby. No visible teeth were present, although unerupted teeth were palpable. Chvostek's sign was positive and Trousseau's test produced carpal spasm. Serum calcium was persistently low and the serum inorganic phosphate was elevated. There was no urinary excretion of calcium. The Ellsworth-Howard test demonstrated a failure to respond to parathormone.

Radiographic studies showed a thickened calvarium together with bilateral symmetrical calcification in the region of the basal ganglia, and some calcification in the cerebellum as well. Unerupted teeth with evidence of faulty development were demonstrated in both the mandible and maxilla. There was mild osteoporosis of the spine and a rather coarse trabecular pattern in the bones of the pelvis. The metacarpals were short, the fourth metacarpal being particularly stunted. Scattered soft-tissue calcifications were observed, particularly near the distal joint of both the upper and lower extremities. There was no renal calcification.

The patient received high doses of calciferol daily, with marked improvement both mentally and physically and complete cessation of convulsions.

Fifteen roentgenograms; 2 photographs; 2 charts; 1 table.

J. A. GUNN, M.D.
Grand Rapids, Mich.

**Calcium Metabolism and Bone Changes in Sarcoidosis.** Gordon Mather. Brit. M. J. **1:** 248–253, Feb. 2, 1957. (Southmead Hospital, Bristol, England)

Data are analyzed from 160 cases of sarcoidosis seen personally by the author. In the majority of the patients the diagnosis was confirmed histologically. About two-thirds of them presented widespread pulmonary disease, and most of the others had bilateral hilar adenopathy.

Radiographs of the hands and feet were available in 120 cases, but only 9 demonstrated bone changes felt to be compatible with, or indicative of, sarcoidosis. A strong correlation was observed between skin sarcoidosis and bone sarcoidosis, in that when lesions in one system were found, involvement of the other could usually be demonstrated.

Estimation of serum calcium in 80 patients showed it to be elevated in 4, while 4 had values below normal. Only a single patient in the entire series had symptoms or signs of disturbed calcium metabolism, and his case is reported in detail.

At least 3 of the patients exhibited a specific sensitivity to calciferol given as a therapeutic measure. The sensitivity manifested itself as considerable elevation of serum calcium levels, with evidence of central nervous system dysfunction and some damage to the kidneys. On the basis of these findings, the author feels that high-calcium, high-vitamin D regimens are contraindicated in sarcoidosis.

Three patients showed peculiar band-shaped calcific opacities in the corneas, possibly a manifestation of disturbed calcium metabolism associated with sarcoidosis.

The conclusions reached are that radiographs of the extremities have a low diagnostic value in sarcoidosis because of the relative scarcity of typical lesions; that patients with cutaneous manifestations of the disease are likely to show osseous involvement; that the treatment of choice is a low calcium and low vitamin D diet, with or without cortisone.

One roentgenogram; 1 photomicrograph; 2 charts; 2 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

**Bone Changes in Myelosclerosis.** F. Mulcahy. Proc. Roy. Soc. Med. **50:** 100–103, February 1957. (Manchester Royal Infirmary, Manchester, England)

This is a summary of the radiologic findings in 19 cases of myelosclerosis in which skeletal surveys were carried out and the diagnosis was confirmed by biopsy. In 10 of the cases no evidence of bone abnormality was demonstrable roentgenographically. The other 9 showed definite changes, practically all in the central skeleton. Skull changes were not seen, and changes in the distal portions of the extremities were unusual. Splenomegaly was present in all cases. The extent of marrow fibrosis and the effectiveness of extramedullary hematopoietic activity appeared to determine the clinical symptoms.

The earliest findings in some cases were widening and increased prominence of trabeculae against a background of slightly increased density. In others there were patchy areas of sclerosis. Still others showed larger areas of generalized amorphous or granular increase in density which obscured the normal architectural detail. Decreased density of cortical bone together with subperiosteal new bone formation, described in previous reports (Vaughan and Harrison: J. Path. & Bact. **48:** 339, 1939), were not encountered. In the spine, the vertebral bodies showed their increased density more clearly near the cartilaginous plates, and in 1 case there were small, dense areas in the centers of the vertebral bodies.

The author urges that when any alteration in bone texture accompanies splenomegaly in a patient past middle age, myelosclerosis should be suspected and a full skeletal survey performed.

Eight roentgenograms.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Salmonella Osteomyelitis Complicating Sickle Cell Disease.** James G. Hughes and David S. Carroll. Pediatrics **19:** 184–190, February 1957. (J. G. H., 848 Adams Ave., Memphis 5, Tenn.)

The authors review the literature on osteomyelitis in sickle-cell disease and report 4 additional cases in which the conditions were associated. The following points are emphasized: (1) that the presence of sickle-cell disease seems to predispose to bone infection; (2)

that Salmonella organisms are frequently the infecting agents; (3) that osteomyelitis occurs as a complication of sickle-cell disease chiefly in young children; (4) that there is a marked disposition to multiple osseous involvement; (5) that roentgenograms of the affected bones have a characteristic appearance.

Clinically, there may be painful diffuse or local swellings or discomfort on motion of the extremities, along with other indications of infection. Roentgenographic findings lag several days behind the clinical manifestations. Several radiographic features appear to be almost specific. Several bones may be involved, and the diaphyses are affected first rather than the juxtaepiphyseal regions. Patchy, destructive medullary lesions progress rapidly, to stop abruptly at the epiphyseal line. Periosteal proliferation and lamination are often prominent. Pathological fractures are not uncommon. A distinctive linear fissuring of cortical bone is seen at times. The fissures traverse the bone longitudinally, adjacent to and equaling in length the medullary areas of involvement.

Treatment of Salmonella osteomyelitis is usually best carried out with chloramphenicol and erythromycin. At times, as exemplified in one of the authors' cases, it may be necessary to prolong the course of therapy extensively to bring the infection under control.

Six roentgenograms. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Fracture-Dislocations of the Cervical Spine.** F. C. Durbin. J. Bone & Joint Surg. **39-B:** 23–38, February 1957. (1 Barnfield Crescent, Exeter, England)

This report deals with the author's experience in 75 injuries of the cervical spine. Fifty-three were dislocations and fracture-dislocations involving the third to the seventh segments. The common mechanism of injury is forced hyperflexion and/or compression of the cervical region. Fractures are of three types: a compression fracture of the vertebral body, fractures of the neural arch, and fractures of the spinous processes. Dislocation may occur without a fracture, if the posterior ligaments are torn. With severe compression fractures of the body there is almost always an associated dislocation or fracture of the articular facets. The dislocation consists in a slipping forward of the upper vertebral body on the lower, with compression of the anterior margin of the latter. For diagnosis lateral radiographs are extremely important and should be obtained in all cases of neck injury. If the extension or neutral lateral film is negative, flexion views should be obtained, under careful supervision, as minimal dislocations will otherwise be overlooked.

Injury to the spinal cord is not too well correlated with the degree of vertebral displacement. Occasionally there will be severe dislocation with minimal or no neurological changes. At times no demonstrable abnormality will be seen on radiographs in spite of irreparable nerve damage. In the latter situation cord damage may be due to a dislocation which has undergone spontaneous reduction, or it may be due to pressure by an intervertebral disk.

All dislocations with neurological involvement demand prompt reduction to insure the best possible chance of recovery. In cases of incomplete tetraplegia rapid recovery has been noted after early reduction, but recovery has not occurred when the cord lesion has been complete for more than twenty-four hours. In the absence of cord or root damage, it is not essential to obtain reduction as an emergency procedure, although it is reasonable to do so. The authors advocate operative treatment in all cases, with wiring of the spine and grafting with iliac bone.

Twenty-seven roentgenograms; 5 drawings; 3 graphs; 3 tables. J. A. GUNN, M.D.
Grand Rapids, Mich.

**Primary Instability of Lumbar Vertebrae as a Common Cause of Low Back Pain.** Francis P. Morgan and Thomas King. J. Bone & Joint Surg. **39-B:** 6–22, February 1957. (F. P. M., 55 Collins St., Melbourne C. 1, Australia)

By "primary" instability of the lumbar vertebrae, the authors mean the type designated by Junghanns as "pseudospondylolisthesis" because there is no neural arch defect (Arch. f. Orthop. **29:** 118, 1930). They record for us their conception of the pathogenesis, the pathological anatomy, the clinical and radiographic findings and the results of treatment.

The only roentgenographic sign of primary instability of the lumbar spine is anteroposterior sliding of the vertebrae upon one another. Associated with instability are fairly widespread incomplete radial tears or fissures between the lamellae of the annulus. The type of lamellar disruption varies somewhat with the portion of the lumbar spine involved. In the two lower lumbar disks the radial tears start at the nucleus and take a sagittal course backward across the inner lamellae toward the thin and narrow posterior longitudinal ligament. Some of the coarser and more peripheral lamellae may resist the force and prevent the nucleus from protruding into the neural canal. The radial anteroposterior tears or fissures may then extend laterally in a branched or "⊥" form and reach on either side just in front of and lateral to the intervertebral foramina, producing nerve root irritation. In the upper lumbar vertebrae (L1-3) the changes most commonly found are semicircular splits or crescentic fissures between the lamellae.

The clinical findings of this syndrome are low back pain with minimal neurologic symptoms. Radiographic examination should be complete, including oblique views, to exclude spondylolisthesis, which is a cause of secondary instability of the lumbar vertebrae. The instability is shown in lateral radiographs of the spine in the sitting or standing positions in both flexion and extension. Specific instructions are given concerning the positioning of the patient for the films.

The most important radiographic finding is anteroposterior displacement of the vertebral bodies. The commonest site of instability is L4-L5, where the upper body moves backward on the lower in extension and forward in flexion. In the rare cases where the fifth lumbar vertebra is unstable on the sacrum, it moves forward in extension and backwards on flexion. Anteroposterior displacement of L5 on S1 may be mistakenly diagnosed unless one is careful to avoid the pitfalls listed by the authors.

The authors report the results of treatment in 500 cases of lumbosacral pain. In 28.6 per cent the diagnosis was primary instability of the lumbar spine. Thirty of this group were treated by spinal fusion, and, of these, 70 per cent were relieved of pain, while an additional 13.3 per cent were improved.

Eleven roentgenograms; 3 photographs; 4 drawings; 3 tables. H. C. JONES, M.D.
Grand Rapids, Mich.

**Bone Defects in the Region of Pars Interarticularis of Lumbar Spine.** Iqbal Chand Pathak. Indian J. Radiol. **11:** 10–16, February 1957. (V. J. Hospital, Amritsar, Punjab, India)

This excellent short article discusses the anatomy, pathology, and possible etiology of defects in the pars interarticularis, or isthmus, of the lumbar spine. Defects are demonstrable in anteroposterior, lateral, and oblique views of the affected area. The characteristic appearance in the oblique film is a defect between the wings of the normal "bow-tie" configuration.

The author reviewed a series of 350 roentgenograms, including 200 of asymptomatic persons and 150 with backache. The incidence of defects in the pars interarticularis in the two groups was 5.5 and 8.0 per cent, respectively. In all cases the defects were localized to the fifth lumbar neural arch.

The etiology of these bone defects still remains undetermined. The congenital theory postulates nonfusion of the two centers of ossification for the lateral halves of the neural arch. Others believe that trauma is the determining factor. One theory is that hyperflexion injuries in infants can fracture the neural arch and produce a defect.

Seven roentgenograms; 3 drawings; 1 table.

PAUL MASSIK, M.D.
Quincy, Mass.

**Roentgen Dose to the Patient in Combined Myelogram-Discogram Study.** Donald deF. Bauer. Northwest Med. **56:** 177–180, February 1957. (North Bend, Ore.)

The skin dose to the patient in combined myelography-discography was calculated from thimble ionization chamber measurements of air dose. On the basis of an average per patient of 16.6 spot films, 6.5 lateral exposures, anteroposterior and lateral preliminary spine films, and fluoroscopy, the author concludes that no area receives more than 35 r to the skin. His estimate of 20 r from fluoroscopy would, however, seem to be far too low, since with his tube output of 6.6 roentgens per minute at the tabletop he is allowing a maximum of three minutes of fluoroscopic time for this combined procedure. This would seem to be a rather gross underestimate of the average fluoroscopic time required for the two studies.

RICHARD H. GREENSPAN, M.D.
University of Minnesota

## THE GENITOURINARY SYSTEM

**Reversible Suppressed Function in Unilateral Renal Malrotation.** Alan L. Abrams and Alex L. Finkle. J.A.M.A. **163:** 641–644, Feb. 23, 1957. (A. L. A., 2340 Sutter St., San Francisco 15, Calif.)

A 39-year-old white woman was admitted for study and treatment following acute onset of sharp, nonradiating pain in the left flank, present for two days. Intravenous urography revealed a normal right urinary tract, but no contrast material was excreted on the left. At retrograde study a left ureteral catheter was passed without difficulty and slight ectasia of the left renal pelvis and calyceal system was demonstrated, without evidence of calculus. Subsequent surgical exploration showed a full 180° of "excessive rotation" of the left kidney so that the hilus lay in a posterolateral position and the renal pelvis faced the psoas muscle. Renal vessels and ureter passed to the hilus posterior to the body of the kidney. The malrotation was reduced by careful surgical dissection, the kidney was placed in a normal position, and a nephropexy was performed. Intravenous urograms obtained a few days after operation showed prompt return of function in the rotated kidney and a relatively rapid resolution of the minimal caliectasis previously described.

The embryologic development of the kidney is reviewed in considerable detail. The reported case is of interest from two aspects: late and acute onset of symptoms at the age of thirty-nine; prompt recovery of renal function following surgical correction.

[Two roentgenograms are reproduced: one preoperative and one postoperative. The two look very much the same, and the condition of malrotation is certainly not obvious. In retrospect, a faint indentation is shown at the lower medial part of the renal pelvis on the preoperative film, possibly suggesting torsion at this point.— J. W. B.]

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

**Hypertension Due to Segmental Infarction of the Kidney.** J. Alex Haller, Jr., Leo R. Radigan, and Andrew G. Morrow. Am. J. Med. **22:** 303–305, February 1957. (National Heart Institute, Bethesda 14, Md.)

A case is reported of unilateral renal infarction resulting in hypertension ninety-five days later. Occlusion of the inferior branch of the left renal artery was demonstrated by retrograde aortography. Following nephrectomy, the patient's blood pressure returned to normal and at the time of writing had remained so for a period of fourteen months.

One roentgenogram; 1 photograph; 1 photomicrograph.

**Aortography and Pneumography in Children.** Robert C. Walter and Willard E. Goodwin. J. Urol. **77:** 323–328, February 1957. (R. C. W., 1015 Gayley Ave., Los Angeles 24, Calif.)

Although a large amount of material has been published on aortography in adults, very little has appeared in the literature concerning the utilization of this procedure in children. The authors have performed aortography in 17 children (19 aortograms), 7 of whom were younger than two and a half years. The technic varies somewhat from that described for adults (Walter and Goodwin: J. Urol. **70:** 526, 1953. Abst. in Radiology **63:** 300, 1954) in that the point of puncture must be relatively further lateral in the left flank because of the more midline position of the aorta in the child. The smallest needle used was 20-gauge; a special 17-gauge needle can be employed for the older children. A preliminary or test injection of 2 c.c. of contrast material, usually 50 per cent Neo-Iopax, was made. The definitive injection varied from 4 to 10 c.c., depending upon the patient's size. All examinations were performed under general anesthesia. In a few instances aortography was combined with presacral oxygen injection for retroperitoneal pneumography studies. The technic for the latter procedure is not different from that for adults, but the amount of oxygen varies from 100 to 200 c.c.

Studies of diagnostic quality were obtained in all of the 17 cases mentioned, without untoward reactions in any. In 2 instances aortography was performed by percutaneous insertion of a polyethylene catheter through the femoral artery.

Indications for aortography in children are about the same as in adults, namely, for demonstration of upper urinary tract anomalies, possible adrenal tumors, and unexplained hypertension. It is in the investigation of adrenal tumors that femoral artery catheterization and presacral air studies are most advantageous.

The authors conclude that aortography is a technically feasible and diagnostically important addition to the urological study of infants and children.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

**Translumbar Aortography Followed by Fatal Renal Failure and Severe Hemorrhagic Diathesis.** Kyril B. Conger, Helen Reardon, and James Arey. Arch. Surg. **74:** 287–293, February 1957. (Temple University School of Medicine, Philadelphia 44, Penna.)

A fatal reaction to translumbar aortography with 20 c.c. of 70 per cent acetrizoate (Urokon Sodium), characterized by complete renal insufficiency and a hemorrhagic syndrome, is reported. The patient was a 12-year-old girl in whom intravenous urograms two years earlier had shown the right kidney to be moderately smaller than the left. She was readmitted to the hospital for a check-up of known hypertension.

Aortography was performed under pentothal anesthesia, and excellent visualization of the blood supply of both kidneys, as well as nephrograms, were obtained. Ten minutes later a film showed no acetrizoate in the renal pelves, and on the following day there had still been no excretion of the medium into the collecting system of the upper urinary tract. Instead, it was being excreted by way of the biliary tract. At this time the patient became ill, with left flank pain, nausea, vomiting, oliguria, and high blood urea nitrogen. The course was progressively downhill, with development of a hemorrhagic diathesis on the fifth day and death on the twelfth. Diffuse benign and malignant nephrosclerosis, tubular degeneration, and extensive interstitial hemorrhage were the principal postmortem findings.

After reviewing other fatal and nonfatal reactions, which are tabulated, the authors conclude (1) that the combination of high iodine concentration and prolonged arterial spasm is the most probable explanation of the toxic change in the kidney; (2) that translumbar aortography should not be used when poor renal function is present.

Three roentgenograms; 2 photomicrographs; 2 photographs; 2 charts; 1 table.

FABIO SALCEDO, M.D.
St. Vincent's Hospital, N. Y.

**Effects of Intra-Arterial Injection of Iodine Contrast Media on the Kidney of the Dog.** Harry S. Thomson, George Margolis, Keith S. Grimson, and Haywood M. Taylor. Arch. Surg. **74:** 39–49, January 1957. (Duke University School of Medicine, Durham, N. C.)

In an earlier study from the same institution (Tarazi, Margolis, and Grimson: Arch. Surg. **77:** 38, 1956. Abst. in Radiology **67:** 776, 1956), a comparison was made of the effect of sodium acetrizoate (Urokon Sodium) and iodopyracet (Diodrast) on the spinal cord of the dog. In the present study, these two media, together with diatrizoate sodium (Hypaque) and sodium diprotrizoate (Miokon Sodium) are compared in respect to their effects on the kidneys. Both immediate and late effects were studied and the influence of position or gravity on the results was investigated.

Under the condition of the experiments acetrizoate and iodopyracet proved most injurious; diatrizoate and diprotrizoate least injurious. A reduction of systemic blood pressure and a constriction of renal volume occurring at the moment of injection are hemodynamic changes associated with greatest renal injury. A prompt increase in pressure and dilatation of the kidney are associated with the least injury.

It had been observed that dogs in the prone position were much less susceptible to cord injury during aortography than dogs in the supine position. The present studies were made with the animals positioned laterally. A definite tendency was evident for the dependent vessels to fill and visualize better than the superior ones. In the single instance of renal injury observed, the dependent kidney showed more serious involvement than the upper kidney.

[This is an excellent and detailed article and should be read in its entirety by those radiologists with an active interest in abdominal aortography.—A. O. M.]

Nine figures, including 6 roentgenograms; 1 table.

ALFRED O. MILLER, M.D.
Louisville, Ky.

## MISCELLANEOUS

**Timed-Disintegration Capsules (Tymcaps)—A Further Study. An in Vivo Roentgenographic Study, Blood-Level Study, and Relief of Anginal Pain with Pentaerythritol Tetranitrate.** Theodore M. Feinblatt and Edgar A. Ferguson, Jr. New England J. Med. **256:** 331–335, Feb. 21, 1957. (T.M.F., 150 Woodruff Ave., Brooklyn 26, N. Y.)

The *in-vivo* roentgen studies of timed disintegration capsules earlier reported by the authors (New England J. Med. **254:** 940, 1956. Abst. in Radiology **68:** 460, 1957) have been extended to pentaerythritol tetranitrate capsules. The timed disintegration of the capsules allowed a quarter of the pentaerythritol nitrate content to be dispersed immediately, the second, third, and fourth quarters becoming available at the beginning of the third, sixth, and ninth hours, respectively, thus providing a dispersal in four segments of three hours each. These roentgen findings were supplemented by blood-level studies and observations on control of anginal pain. Although the rise in blood levels of pentaerythritol nitrate and the control of pain are delayed in relation to the disintegration of the capsule as shown roentgenographically, this is true only on the first day of medication, due presumably to the nature of the drug. On the basis of these studies, conclusions are drawn as to the preferred technic of administration. These, of course, are applicable only to the drug used in the experiments.

Four roentgenograms; 2 graphs.

**Coding System for a Radiology Department.** Edith G. Bayers. Channel-MAMRL (Official Publication of the Massachusetts Association of Medical Record Librarians), September 1957. (Cambridge City Hospital, Cambridge 39, Mass.)

The author, a medical record librarian, describes a simplified coding system devised for a department of radiology faced with a critical shortage of trained secretarial help. The anatomical sections were selected from the Standard Nomenclature of Diseases and Opera-

tions and were numbered to agree. Within the anatomical sections are 8 subheads based generally on the system in use at the Rochester, New York, Hospital, although somewhat different in the arrangement and categories chosen. Within this framework of anatomical sections and categorical subheadings, an alphabetical filing is followed. Cards 8 × 5 inches are used for the file, with guides of one color for the anatomical sections and another color for the subheadings. The system has answered all questions put to it after being in use more than a year and a half and serves the radiology department as a disease index.

FRANCIS A. HERZAN, M.D.
Cambridge, Mass.

## RADIOTHERAPY

**Carcinoma of the Mouth. I. Carcinoma of the Lip, a Statistical Study of 280 Cases. II. Intraoral Cancer, a Statistical Study of 223 Cases.** Robert B. Clifton and John C. Hardin, Jr. Am. J. Surg. **92**: 890–893, 894–898, December 1956. (Confederate Memorial Medical Center, Shreveport, La.)

*Carcinoma of the Lip:* The authors analyze the results of treatment of 280 cases of squamous-cell carcinoma of the lip collected over a period of twenty-three years. In this group the lesion was most prevalent in the seventh decade, occurring most frequently at a point on the lower lip equidistant between the midline and the commissure. Almost 94 per cent of the patients were white males.

The majority of the cases were treated by either radiation or surgery alone; in a small percentage these modalities were combined. Irradiation only was used in 201 cases, while 50 were treated solely by surgery. There is no separation of the irradiated cases into those considered curable at the time of the initial treatment and those in whom only palliation could be expected.

The absolute survival rate (total five-year survival compared to total number dead and lost to follow-up) was 42.9 per cent for those treated by irradiation and 73.7 per cent for those operated upon. (In arriving at these figures 43 cases treated in 1951 and later are omitted.) The corrected rate (total five-year survival compared to total dead, with omission of those lost to follow-up) was 73.6 per cent for the irradiated group and 100 per cent for the surgical group (14 cases). The authors believe that actually the results of the two methods of therapy parallel each other more closely than this series indicates, especially since the number treated operatively was small and the irradiated group included some cases treated palliatively. Their conclusion is that the two methods offer about the same result in uncomplicated carcinoma of the lip.

*Intraoral Cancer:* The 223 cases of carcinoma of the mouth, also collected over twenty-three years, include 75 of the buccal mucosa; 36 of the tongue; 32 of the floor of the mouth; 25 of the lower gum; 23 of the tonsil; 19 of the upper gum; 13 of the soft and hard palate. These were found more commonly in the forty- to eighty-year age group, with 40.8 per cent occurring in males, Caucasians predominating. It is interesting to note that the cases among Negroes in this series were divided equally between males and females.

Metastases occurred in 30 per cent of the cases, from lesions of the tonsil, tongue, floor of mouth, lower gum, buccal mucosa, palate, and upper gum, in order of decreasing frequency. Prognosis was found to be better in patients whose symptoms were of less than one year duration, and the chance of cure was almost twice as good if the lesion measured less than 2 cm. in diameter.

The majority of patients (157) were treated by irradiation or by irradiation and surgery combined. The remainder were treated by surgery alone. There was no breakdown of the irradiated cases into curable or palliative groups based on the condition at the time of initial therapy.

In the group treated only by irradiation, the absolute survival rate (based upon 139 cases treated prior to 1951) was 11.5 per cent, and the corrected survival rate 16.7 per cent (all lesions). The best results were in lesions of the upper gum (absolute 33.3 per cent; corrected 42.8 per cent). Combined radiation and surgical therapy (18 cases) produced a five-year absolute survival rate of 33.3 per cent, and a corrected five-year survival rate of 37.5 per cent, with lesions of the upper gum again showing the best results (absolute 66.6 per cent; corrected 100 per cent). Surgery alone (18 cases) yielded an absolute survival rate of 33.3 per cent and a corrected survival rate of 50.0 per cent.

The authors conclude that eventually the best results in treatment of intraoral cancer will be by a combination of radiation and surgery.

Ten tables. WILLIAM S. HARWELL, M.D.
Shreveport, La.

**Radiation Therapy of Malignant Tumors of the Oral Cavity.** Erich M. Uhlmann. Am. J. Surg. **92**: 877–884, December 1956. (Michael Reese Hospital, Chicago, Ill.)

Malignant tumors of the oral cavity offer a special challenge to the radiotherapist and require special technical applications for successful treatment. Although in readily accessible areas, many intraoral tumors are in an advanced stage when first seen. Recently the trend has been toward surgical treatment. In many instances a combination of radiation and surgery is the method of choice. In general, highly anaplastic tumors are more suitable for irradiation.

Various forms of radium appear to be the most desirable modality in the radiation treatment of oral cancer, with interstitial seeds or needles the most effective form. This gives a high concentration of ionizing radiation in the tumor, with a rapid decrease in intensity in the surrounding tissue. Telecurietherapy with radium "bombs," where available, and small cobalt-60 sources (30 to 50 curies) is a useful adjuvant to interstitial therapy.

Radiation therapy of carcinomas of the tongue permits conservation of tissue, with maintenance of normal function of that organ. Lesions of the tip of the tongue and frenulum offer the best prognosis. They can be treated by x-rays in the 200–250-kv range, or by a combination of interstitial and external irradiation, the author preferring telecurietherapy for the external radiation. A minimum of 7,000–8,000 r should be given. More than 50 per cent of carcinomas of the tongue are on the lateral borders, and these are best treated by combined interstitial and external radiation.

The external radiation should cover the areas of immediate lymph drainage. Extension of these lesions to the floor of the mouth indicates a poorer prognosis. For tumors of the base of the tongue external irradiation is the procedure of choice, with a minimum tumor dose of 7,000 to 8,000 r. Implantation of radon seeds in this area is recommended, if feasible.

Sixty to seventy per cent of carcinomas of the tongue have metastases to lymph nodes at the time of diagnosis, and these must be controlled by radical neck dissection or radiation. In the 30 to 40 per cent of patients who do not present clinical evidence of metastasis, prophylactic irradiation of the drainage areas is not recommended. Five-year survival rates for all cases treated are between 25 and 30 per cent; in early lesions the rate is almost doubled.

Carcinoma of the floor of the mouth is treated successfully in a manner similar to that described for the tongue, with five-year survival rates of 35 to 40 per cent. The advantage of radiation therapy over surgery lies in the fact that radiation can be applied to all stages of disease, producing a lesser degree of mutilation, with end-results at least comparable to radical surgery.

Radiation therapy is preferable to surgery in lesions of the buccal mucosa unless there has been invasion of bone. Local interstitial radium combined with external radiation, with a minimum tumor dose of 7,000 to 8,000 r, is recommended. Five-year survivals range up to 60 per cent, with lesions in the posterior portion of the buccal cavity offering a less favorable prognosis.

Surgery, as a general rule, is the primary treatment of carcinoma of the hard palate, with irradiation postoperatively. Primary lesions of the soft palate are irradiated; metastases in this group are frequent, requiring radical neck dissection, often bilateral.

Primary carcinomas of the tonsils are relatively rare, and are best treated by radiation, with a minimum of 7,000 to 8,000 r to the tonsils and regional nodes. For the most part, treatment is by external irradiation, supplemented by radon seeds in suitable cases. In the best reported results, five-year survivals are between 20 and 25 per cent.

W. S. HARWELL, M.D.
Shreveport, La.

**Local Infiltration Anaesthesia for Radium Implantation, in Oral Cancers.** O. N. Saxena. Indian J. Radiol. **11:** 7–9, February 1957. (Medical College, Agra, Uttar Pradesh, India)

In 20 cases of cancer of the cheek to be treated by radium implantation, the author used local anesthesia with 2 per cent Novocaine. Local anesthesia for radium implantation has the advantages of convenience, avoidance of postoperative vomiting, and full patient cooperation. Also one is relieved of the necessity of depending upon an anesthetist. The dangers are distortion of the local structures and possible spread of the tumor by infiltration of the anesthetic. The author believes that the advantages outweigh the disadvantages, and advises local anesthesia routinely.

Two roentgenograms; 1 table.

PAUL MASSIK, M.D.
Quincy, Mass.

**Malignant Tumors of the Nose and Paranasal Sinuses.** Kenneth D. Devine, Paul W. Scanlon, and Frederick A. Figi. J.A.M.A. **163:** 617–621, Feb. 23, 1957. (Mayo Clinic, Rochester, Minn.)

A history of the development of treatment for malignant tumors of the paranasal region is given in considerable detail. In recent years there has been a strong trend toward "wide open" surgery, with adequate exposure of the neoplasm and excision of malignant and a generous amount of adjacent normal tissues by sharp dissection. Refinements in surgical and allied technics will allow successful attack on many neoplasms of this region previously inaccessible.

The authors' present mode of attack consists of attempted complete excision of the tumor-bearing area in selected cases, followed by carefully planned courses of maximal irradiation. In some instances electrocoagulation is also used. Roentgen therapy with conventional voltage and conventional cross-fire technics is now relegated to the management of cases for palliation only. The typical case of carcinoma of the maxillary antrum toward which curative therapy is directed will receive, first, wide exposure of the tumor area followed by sharp dissection for removal of as much of the tumor as possible and adjacent invaded normal tissues. Most cases will then receive a radium mold designed to hold the radiating source in the central area of the antrum where a surface dose of 4,000 to 5,000 r is delivered in about two weeks. This will be supplemented by a dose of 4,000 to 5,000 r delivered by cobalt teletherapy [to the midplane of the antrum—J. W. B.] over a period of four weeks. In some instances the postoperative field is given cobalt teletherapy alone, with a recommended 8,000 to 8,500 r skin dose in four to five weeks through a single anterior oblique field on the affected side. This will deliver approximately 6,000 r to the posterior and medial aspect of the antrum at presumably the deepest point of tumor invasion. In cases where the floor of the orbit is involved and the eye has not been removed, no attempt is made to shield it from irradiation.

With malignant tumors of the ethmoid sinuses, surgical exposure and sharp dissection of the neoplasm are again first choice. Electrocoagulation will play a greater part here, but is almost always followed by topical application of radium. Surface doses of 6,000 to 7,000 gamma r in single applications lasting from three to four hours are tolerated surprisingly well. Some cases will receive supplemental irradiation from cobalt teletherapy in the range of 4,000 to 5,000 r over three weeks through a direct nasal field. This longer procedure is reserved for individuals showing invasion by the tumor beyond the bony confines of the ethmoid sinuses. Patients having lymphoepithelioma or lymphosarcoma receive external roentgen therapy or cobalt teletherapy as the sole method of treatment.

Some general comments are made regarding results but no statistics are quoted for the authors' own series.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

**Carcinoma of the Maxillary Sinus.** Robert S. Pollack. Ann. Surg. **145:** 68–73, January 1957. (450 Sutter St., San Francisco 8, Calif.)

The author discusses the combination of surgery and postoperative irradiation for carcinoma of the maxillary antrum and analyzes the results in 31 cases. He emphasizes radical treatment of local disease, since death is usually due to the local effects, such as infection, necrosis, hemorrhage, and inanition. Also, distant metastases are rare and cervical node involvement is late.

The primary attack is surgical. The author criti-

cizes the initial use of x-ray therapy since (1) surgical drainage will eventually have to be done in all cases; (2) radiation increases necrosis of the bony walls; (3) if radium is used, large openings must be made in the antrum. Radiotherapy postoperatively directed to the residual tumor in an open exposed surface is considered much more satisfactory and more easily delivered. This may take the form of radium plaques, moulages, or needles to local areas in combination with external radiation.

The logical procedure is, first, a well planned operation which will allow the surgeon to follow the spread of the tumor and specifically determine the areas where he may not have removed all the cancer, as at the cribriform plate, pterygoid muscles, or sphenoid sinus. He can then direct the roentgenologist to these special areas and also present him with a wide-open, exposed surface instead of a hidden, bone-enclosed cavity. As soon as satisfactory healing has taken place, radiotherapy is started, being concentrated in the questionable areas as determined at operation. Radiation is given to tolerance whether or not gross evidence of tumor is present.

Analysis of a series of 31 patients shows 13 alive with no evidence of disease between one and five years after operation, 7 of these over three years. In most of these cases (22) the stage of the disease was judged to be advanced when treatment was begun. The surgical procedure is well illustrated by means of drawings.

Six figures. LOUIS J. SANFILIPPO, M.D.
St. Vincent's Hospital, N. Y.

**Glomus Jugulare Tumour: A Case Report.** G. Efron. South African M. J. **31:** 164–168, Feb. 23, 1957. (Groote Schuur Hospital, Cape Town, South Africa)

The author reports a case of glomus jugulare tumor in a twenty-nine-year-old African woman who complained of unilateral deafness and tinnitus, vertical headache, and a persistent throbbing sensation on the left side of the head. Her voice had become weak and hoarse and there were double vision on looking to the left, dysphagia for solids, and wasting of the left side of the tongue. Physical examination showed paralysis of the left 6th, 9th, 10th, 11th, and 12th cranial nerves. A systolic bruit was audible over the left mastoid region, and the left external auditory meatus was obstructed by a polypoid mass, which on biopsy was found to resemble closely the "angioma-like type of glomus jugulare tumor."

The tumor was irradiated through three circular fields for a total skin dose to each field of 4,050 r (focal skin distance, 50 cm.; Thoraeus filter; 220 kv.; 15 ma.). The estimated tumor dose was 3,600 to 4,800 r. The headache and tinnitus improved, but at the time of the report, several months after treatment, there had been no change in the physical signs.

The various aspects of glomus jugulare tumors are discussed. Although roentgen therapy has no effect on carotid-body tumors, glomus jugulare tumors have been said to be radiosensitive. The radiotherapeutic action would appear to be mainly vascular (probably thrombosis of the vessels), whereby a reduction in the blood supply results, with consequent shrinkage in the bulk of the growth, rather than destruction of the tumor cells themselves.

Five roentgenograms; 2 photomicrographs; 1 photograph; 1 diagram.

**Early Diagnosis of Deterioration after Radiation Therapy of Carcinoma of the Cervix.** H. B. Atlee and Carl Tupper. Canad. M. A. J. **76:** 181–183, Feb. 1, 1957. (Dalhousie University, Halifax, N. S., Canada)

The authors have adopted a policy of treating all cases of cervical cancer by irradiation, resorting to surgery only when the response is poor or there is evidence of recurrence. Studying these unfavorable cases, they found the earliest indications of deterioration to be inexplicable loss of weight, slough or ulcer at the vaginal vault, and extension of induration from the cervix toward the pelvic walls.

By making careful use of these diagnostic criteria, they have operated upon 51 women since 1952. In the same period 28 women, in Stages I and II when first seen, died of cancer without benefit of operation. In 10 cases the operation had to be abandoned because of extension of the growth, discovered after the abdomen was opened. In the cases in which operation was completed, the bladder had to be removed in 10 and the rectum in 2, though the patients had been in Stage I or II when originally treated.

More and more patients are now being brought back for a check-up at shorter intervals during the first year following irradiation, and surgery is being undertaken in every case in which there is the least suspicion of deterioration.

Four tables.

**A Follow-Up Study of Hemangiomas of the Skin Treated and Untreated.** Walter Falk and David Levy. J. Dis. Child. **93:** 165–172, February 1957. (Rambam Government Hospital, Haifa, Israel)

Sixty infants and young children, presenting a total of 72 nevi, were examined four to eight years after they had first been seen at one month to four and a half years of age. In the majority of the cases the lesions had been left to follow their natural course, without treatment. Fourteen had been treated by radium either because of special indications or at the insistence of the parents.

The ultimate results are classified as (1) perfect when no trace of the nevus remained and no scar presented after its disappearance; (2) fair, if the nevus was replaced by a level scar without retraction of the edges; (3) poor, when a disfiguring scar with retraction, depression, and discoloration remained; (4) a failure, if there was no change in size or color. With these criteria, the results of conservative therapy were far superior to those of radium, irrespective of the site of the lesion.

In general it is agreed that the elevated strawberry-type nevus will disappear in a period of five years. The averages culled from the literature suggest that at least 90 per cent of such lesions will have healed by the age of seven. The flat, portwine type, however, nearly always persists. These statistics still leave a group of patients in whom treatment must be seriously considered. The problems of treating an ulcerated lesion, one that is unsightly, or one that causes "functional impairment deformity" must be solved in the individual case. One must also consider the feeling expressed in the literature that the older the child the less sensitive the lesion is to radiation.

Of the 54 untreated nevi, 48 healed without a trace. Those treated with radium showed a frightening percentage of poor results or even failures as judged by the above criteria. Active therapy, preferably by x-ray

irradiation, should be reserved for those nevi which cause functional impairment deformity with the added dangers of ulceration. These heal poorly even after therapy and at best leave a large scar after the occurrence of ulceration, with or without hemorrhage.

Six tables. SAUL SCHEFF, M.D.
Boston, Mass.

**Hemangiopericytoma; Report of a Case, with Special Reference to Roentgen Therapy.** Kurt H. Kent. Am. J. Roentgenol. **77:** 347–356, February 1957. (St. Francis Hospital, Lynwood, Calif.)

Hemangiopericytoma is a vascular tumor composed of pericytes and capillaries of endothelial sprouts. The proliferating tumor cell is the pericyte. Histologic examination is required to prove the diagnosis, although the histogenesis is unproved. The tumor varies in respect to location, age, sex, growth rate, and clinical appearance. It may be benign, locally invasive, or widely metastatic. Tumors arising in the lower abdomen and the lower extremities are more likely to be malignant. The prognosis is variable. In those cases reported in the literature, treatment has been primarily surgical, with occasional adjuvant roentgen therapy.

The author reports a single case of hemangiopericytoma in a 36-year-old white male. The tumor arose in the calf of the right leg and metastasized widely throughout the body. Roentgen therapy was delivered to the primary site and to the lower portion of the left lung. The calf received a tumor dose of 4,440 r, and the lung 2,163 r. The primary tumor softened and became less painful, but it did not disappear. The left lung cleared but untreated lesions in the right lung were unchanged. The tumor is considered, therefore, to be radiosensitive, and it is believed that deep roentgen therapy has a definite place in the palliative management of this disease. The patient died from metastases eleven months after diagnosis.

Eight roentgenograms; 1 photomicrograph; 1 table.
RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

**Status Lymphaticus and Enlargement of the Thymus. With Report of a Case Successfully Treated by the X-Ray.** Alfred Friedlander. Arch. Pediat. **74:** 67–77, February 1957.

This report of the successful roentgen treatment of a case of status lymphaticus and enlargement of the thymus, reprinted from *Archives of Pediatrics* for July 1907, was first read before the Academy of Medicine of Cincinnati in March of that year. The patient was a child of two months. Twelve exposures appear to have been given within a period of a month, producing a diminution in the size of the thymus and of the bronchial lymph nodes with no adverse effects apparent three years later.

**Roentgen Irradiation of the Hypophysis in Diabetes Mellitus: Results Obtained in 54 Patients.** Carlos Santos and Eurico Pais. Gaz. méd. portuguesa **10:** 57–70, January-February 1957. (In Portuguese)

As indicated by the title, the authors report their results with pituitary irradiation in 54 diabetic patients. They are concerned chiefly, however, with a special technic—so-called microlocalized radiotherapy—employed in selected cases. The cases reported are divided into two groups according as conventional irradiation or the newer procedure was used.

Thirty-three patients, mostly insulin-rsistant, were irradiated with the conventional roentgen beam, 100–150 r per session, to a total of 3,000–3,500 r (presumably tissue dose), over the pituitary. In 9 of these there was at least transitory improvement in the metabolic status.

The method of microlocalized irradiation was developed by one of the authors (C. S.) in 1953. The device employed is a lead mask with a circular opening, the surrounding circumference being divided into forty segments. These are visualized on the first orientation film, thus permitting the placement of additional lead masks, with the help of which the authors claim they can irradiate at will either the anterior lobe of the pituitary, its posterior lobe, or the hypothalamus, while the remainder of the structures are shielded (at least from the primary beam). It was felt that irradiation of the posterior pituitary and of the hypothalamus could influence an existent diabetes mellitus by acting upon the secretion of anti-diuretic hormone.

The selection of cases for treatment by this means was made on the basis of a test developed by the second author (E. P.), using a compound H 365 prepared in 1949 by Bou-Hoi. This compound (called also POP, after its chemical formula, para-oxy-propiophenon, a grossly halved molecule of diethylstilbestrol) was found to exert a very transient hypoglycemic action, presumably by inhibiting the internal secretion of the pituitary. It was believed, therefore, that in a patient with diabetes mellitus a drop of at least 15 per cent in the level of the blood sugar in response to administration of the preparation would mean that the pituitary played some role in the particular case and that therapy directed to the gland (as by irradiation) might have a chance of success.

Accordingly, a second group of patients, numbering 21, with a positive POP test were subjected to irradiation of the pituitary by the microlocalized method. The average dose was low, about 25 r; one patient, for instance, received 18 doses of 25 r over the anterior lobe of the pituitary, one of 25 r over the entire sella, and finally three doses over the middle third of the pituitary (200 kv, 0.5 Cu plus 1.0 Al, 80 cm. T.S.D.). In 16 patients, the blood sugar returned to "normal" values, and remained there without further treatment of any kind. Three others showed improvement. The authors believe that in certain cases of diabetes mellitus (those with positive POP test, *i.e.* caused by pituitary "dysfunction") "microlocalized" roentgen therapy is the treatment of choice.

Seven figures. MARION F. MAGALOTTI, M.D.
Cook County Hospital, Chicago

**Surgery Versus Irradiation of Tonsils and Adenoids Relative to Conduction Deafness.** Shirley H. Baron. J.A.M.A. **163:** 522–525, Feb. 16, 1957. (516 Sutter St., San Francisco 2, Calif.)

Tonsils and adenoids play a major role in the development of those diseases which lead to conduction deafness, as suppurative otitis media, serous or secretory otitis media, and eustachian tube obstruction. Deafness of this type is usually reversible if treatment is early and adequate. The author bases her opinions in this respect on a personal experience extending over many years and supports them by reference to the work of others. She is convinced that meticulous surgical removal of tonsils, adenoids, and recurrent lymphoid masses is the procedure of choice. Of irradiation she says:

"Irradiation has been overrated in its ability to shrink lymphoid tissue with the dosage considered to be within the range of safety. It may be of some value in an occasional case where thorough surgery has failed in its goal. If irradiation is limited to these patients, the number requiring this therapy will be small. Irradiation is not and should not be used as a substitute for good surgery, or as an escape for inadequate surgery."

Five graphs.

B. J. HILL, M.D.
University of Michigan

**Comparison of Surgical Removal of Tonsils and Adenoids with X-Ray Treatment.** Jack A. Weiss. J.A.M.A. **163:** 526, Feb. 16, 1957. (111 N. Wabash Ave., Chicago, Ill.)

The author reports his observations on a small group of children in whom tonsils and adenoids were removed unilaterally and the remaining tonsils were irradiated "by the standard technique" and removed after an interval of a year. Microscopic examination of the irradiated tonsils showed only such minor changes as were to be expected with moderate radiation dosage. No effects were observed that could be correlated with a decrease in infectiousness, and irradiated tonsils are therefore believed to remain a potential focus of infection.

Irradiation has its greatest value in alleviation of obstruction to nasal breathing. Its best application is in cases where surgery is contraindicated, refused, or deferred and in treatment of lymphoid remnants in and around the eustachian tube orifice.

B. J. HILL, M.D.
University of Michigan

## RADIOISOTOPES

**Thyroid Uptake Measurements.** G. J. Hine, B. A. Burrows, and J. F. Ross. Nucleonics **15:** 54–57, January 1957. (G. J. H., VA Hospital, Boston, Mass.)

In this paper the authors discuss the general principles involved in thyroid uptake measurements, as well as the properties of plastic scintillators instead of the more usual NaI (T1).

To estimate radioiodine uptake as percentage of administered dose, one must compare the $I^{131}$ activity of the dose with that distributed in the patient's thyroid. The first measurement can be made on an aliquot of the dose, prepared either as a dry source or as a liquid source of 1–100 ml. volume. The source for the other measurement is the distribution in the gland.

Various sources of error in uptake measurements are analyzed. The size and shape of the thyroid and positioning of the detector will influence the results. Geometrical errors of this sort may be minimized by using a distance of at least 50 cm. from thyroid to detector.

The second important consideration in making accurate uptake measurements is insuring that the detector responds equivalently to $I^{131}$ whether it is in the standard or in the patient's thyroid. The primary gamma rays from $I^{131}$ are mainly of 364-kev energy. When these rays pass through tissue, some of them are degraded in energy by Compton scattering processes. Thus, if the scattering conditions in the standard are not the same as in the actual thyroid, a true comparison of activities cannot be obtained since the detector normally responds differently to gamma rays of different energy.

Three methods of overcoming this difficulty are described in the paper, under the following headings: (*a*) NaI with pulse-height discrimination, (*b*) use of lead filters, (*c*) reference source in water phantom. The necessity for a pulse-height discriminator can be obviated by using a plastic scintillator, since scattered gamma rays contribute to a less extent to the total counting rate. Plastic scintillators also have the advantage of lower cost and ease of handling. They are unbreakable and stable, whereas NaI crystal is fragile and has to be kept in an airtight container because of its highly hygroscopic property.

Eight figures; 1 table.

ROSS GARRETT
Memorial Center, N. Y.

**The Intrathoracic Use of $Au^{198}$ after Pneumonectomy. A Preliminary Study.** Rex B. Perkins, Marshall S. Little, and William L. Hawley. Arch. Surg. **74:** 145–148, January 1957. (University of Alabama Medical Center, Birmingham 3, Ala.)

One of the reasons for the rather disappointing five-year survival rate following surgery for bronchogenic carcinoma is the presence of tumor cells in the mediastinal lymph nodes, especially those on the opposite side, not customarily removed even in the radical pneumonectomy. In the attempt to deal with these nodes by radiation, it seemed feasible to place a radioactive substance in the empty hemithorax immediately postoperatively, in the hope that the substance would be picked up by the pleural and mediastinal lymphatics and carried to the mediastinal nodes. Colloidal $Au^{198}$ was chosen, as this delivers 95 per cent short-range (mean penetration 0.38 mm.) beta radiation and has been shown to be carried to the mediastinal nodes after intrabronchial instillation.

Ten adult mongrel dogs were subjected to a left pneumonectomy. The bronchial stump was relatively long and was closed with heavy silk and not covered with pleura. The raw hilar mediastinal surface was not pleuralized. Radiogold colloid (specific activity averaging 25 mc/c.c.), 1 to 4 c.c., was injected into the left chest, and the animals were killed at intervals of two to twenty-two weeks, autopsies being performed from the right. Specimens removed consisted of the right paratracheal, right main bronchus, subcarinal, and left main bronchus nodes and biopsy specimens of the trachea, bronchial stump, and other adjacent areas.

In no dog did infection occur. By radioautographs, the colloidal gold appeared to have distributed itself around the empty hemithorax and adhered to all exposed structures. The bronchial stumps shared in the exposure to radiation but in all dogs the stump was well healed. All nodes examined by radioautography showed evidence of the presence of $Au^{198}$.

These studies demonstrate that radioactive gold is, in fact, taken up by the mediastinal nodes even on the opposite side. Radioautographs show this radiation activity to be in the substance of the node and not mere surface contamination. The fact that dye injected near certain cancers tends to go to normal nodes and circumvent cancerous nodes mitigates against the con-

cept that $Au^{198}$ in the pleural space after pneumonectomy may be concentrated in cancerous mediastinal nodes in quantities sufficient to deliver lethal radiation. Nevertheless, the method deserves a well controlled clinical evaluation.

One table.

ALFRED O. MILLER, M.D.
Louisville, Ky.

**In Vivo Measurement of Organ Size Using a Gamma Radioactive Point Source ("Scintillometry") with Special Reference to Applications in Gynecology and Obstetrics.** Erik Odeblad, Sven Erik Englund, and Leo Meurman. Acta radiol. **47:** 157–167, February 1957. (Sabbatsbergs Sjukhus, Karolinska Institutet, Stockholm, Sweden)

A method of measuring linear distances *in vivo* is presented, based on the inverse-square law and exponential transmission function for nuclear gamma rays. For the uterus, sources of radiation, between 2 and 10$\mu$c of $Co^{60}$ in liquid form, were kept in thick-walled glass tubes, and introduced inside the rubber glove at the side or top of the palpating vaginal finger. A shielded directional scintillation counter was placed abdominally, with the uterus interposed between it and the source. The distances are read from calibration curves obtained by phantom experiments. The authors regard scintillometry as a step toward a more objective assessment of organ size than is obtained by the conventional gynecologic examination.

Ten diagrams; 4 tables.

LAWRENCE FETTERMAN, M.D.
Cleveland City Hospital

## RADIATION EFFECTS

**The Relative Biological Effectiveness of Various Ionizing Radiations in Mammalian Systems.** John B. Storer, Payne S. Harris, John E. Furchner, and Wright H. Langham. Radiation Res. **6:** 188–288, February 1957. (Los Alamos Scientific Laboratory, Los Alamos, New Mex.)

The results of 39 experiments on the relative biological effectiveness (RBE) of nine different ionizing radiations are reported. From one to ten quantitative biological responses of rats and/or mice to radiation were utilized with each type of radiation. Each of the quantitative methods is described in detail. All values for RBE are expressed relative to radium $\gamma$-rays which served as the baseline radiation. The radiations were delivered in single acute exposures, and the biological responses were all of an acute type with latent periods of thirty days or less. Under these conditions, the following results were obtained:

1. Cobalt$^{60}$ $\gamma$-rays were found to have an effectiveness identical to radium $\gamma$-rays.
2. The 4-MEV $\gamma$-rays from neutron capture in graphite were generally less effective than radium $\gamma$-rays.
3. The RBE of 250-kvp x-rays varied with the response measured. For the production of thirty-day lethality and testicular atrophy, x-rays were slightly more effective than radium $\gamma$-rays.
4. Tritium $\beta$-particles and 14-MEV neutrons showed RBE values of about 1.5.
5. Three of the four RBE values for fission neutrons were approximately 2.0, and the fourth was 1.0.
6. The RBE of the 0.6-MEV protons produced by thermal neutrons was measured in ten different systems. The values ranged from 1.0 to 4.9, depending on the system. The majority of the values fell between 1.0 and 2.5.
7. The heavy particles from thermal neutron capture by boron$^{10}$ ($\alpha$-particles and $Li^7$ recoils) were only 1.3 times as effective as radium $\gamma$-rays for the production of thirty-day lethality in mice, but were 3.5 times as effective in the production of testicular atrophy.
8. Fission fragments from neutron capture by plutonium were found to be less effective than radium $\gamma$-rays.

On the basis of these results, it was tentatively concluded that relative biological effectiveness, in mammalian systems, increases with increasing lineal energy transfer (LET) of the radiation, reaches a maximum, and then decreases, with very high values for LET. Some of the implications of this conclusion are discussed.

Fifty-four figures; 11 tables; a bibliography of 149 references.

**Experimental Investigations on the Influence of Roentgen Irradiation on the Growth of Multiple Tumours.** Antero Voutilainen. Acta radiol. **47:** 149–156, February 1957. (University of Helsinki, Helsinki, Finland)

The author studied the effect of irradiation on transplanted rat ITB tumors. The tumors were implanted into two sites, namely, the interscapular and gluteal regions. The interscapular tumors were irradiated, while the gluteal tumors received no irradiation but were followed for change in size and mitotic activity. Similar observations were made in an unirradiated control series.

Ten daily treatments of 500 r were given to the experimental group, and biopsy specimens were obtained at the commencement of treatment and on the fifth and tenth days. Not only did the irradiated tumors show a reduction in size as compared to the unirradiated tumors in the same rats, but the latter showed a significant inhibition of both growth and mitotic activity in comparison to the tumors in the control series.

It is suggested that irradiation liberates or activates some substance which has an inhibitory effect and, through the blood stream, can affect even unirradiated tumors.

Three diagrams; 2 tables.

LAWRENCE FETTERMAN, M.D.
Cleveland City Hospital

**Comparative Study of the Physiological Effects of X-Irradiation and Resistance to Traumatic Shock.** J. M. McKenna and B. W. Zweifach. Radiation Res. **6:** 126–136, February 1957. (Department of Pathology, New York University-Bellevue Medical Center, New York, N. Y.)

Exposure of rats to whole-body x-irradiation was carried out, different groups receiving from 350 to 900 r; 350 r was just on the borderline of lethality, and 900 r

was a 90 to 95 per cent lethal dose. The animals remained inordinately susceptible to a standardized type of trauma (in the Noble-Collip drum) for as long as sixty days following exposure to 750 to 900 r, whereas those which had received 350 to 500 r recovered their capacity to withstand traumatic shock within two to three weeks. The increased susceptibility did not appear to be related to the leukopenia and thrombocytopenia which accompany exposure to total-body irradiation. In contrast, the resistance to shock engendered by repeated exposure to sublethal trauma was not lost following whole-body exposure, again despite a comparable fall in leukocyte levels. Adaptation to drum trauma did not have a protective carry-over against the lethal effects of whole-body irradiation. The interjection of x-irradiation prior to a training regime did not interfere with the development of trauma-resistance. The findings suggest the possibility of a derangement of the reticuloendothelial system during the early days following exposure to x-rays.

Five tables. AUTHORS' ABSTRACT

**Experimental Investigations on Cataract Formation Following Whole-Body Roentgen Irradiation.** Erik Poppe. Acta radiol. **47:** 138–148, February 1957. (Rikshospitalet, Oslo, Norway)

The author's purpose in the project described here was to study the smallest cataract-producing dose of total-body irradiation, and to investigate the possibility of causing cataract with dosages not ordinarily resulting in other lasting damage.

Sixteen rabbits were irradiated with doses ranging from 200 to 800 r and followed for three and a half to twenty-four months. The epithelium of the crystalline lens was shown to be highly radiosensitive and lens opacities were produced with the lowest doses of total-body irradiation. These changes were identical with those observed after local irradiation of the eye.

Following irradiation with threshold cataract-producing doses, the lens opacities may, after a certain time, be the only remaining "critical" and morphologic sign of radiation injury.

Ten photomicrographs; 6 diagrams.

LAWRENCE FETTERMAN, M.D.
Cleveland City Hospital

**Effects of High-Intensity X-Irradiation on the Retina: A Histological, Histochemical, and Chemical Study in the Rabbit.** Sidney P. Kent and Arnold A. Swanson. Radiation Res. **6:** 111–120, February 1957. (Department of Pathology, School of Aviation Medicine USAF, Randolph Air Force Base, Texas)

The retinas of 90 rabbits were examined chemically and histochemically for succinic dehydrogenase and glycogen. They were also studied histologically. Forty-five of the animals had received 6,000 r of x-irradiation to the eyes, while the remainder served as nonirradiated controls. Five irradiated and 5 nonirradiated control animals were sacrificed by decapitation at various intervals, from half an hour to seventy-two hours, after irradiation.

Morphologic changes consisting largely of pyknosis in the outer nuclear layer and fragmentation of the bacillary layers were first observed four hours post-irradiation, and were noted in all subsequent irradiated groups. The glycogen content, particularly of the visual cell layer, increased in the four-hour irradiated group, and the succinic dehydrogenase activity decreased. Both changes were noted in all subsequent irradiated groups.

Twelve figures.

**Acute X-Ray Lethality Studies with the Hamster. The $LD_{50}$, Death Rate, and Recovery Rate.** Henry I. Kohn and Robert F. Kallman. Radiation Res. **6:** 137–147, February 1957. (Radiological Laboratory, University of California School of Medicine, San Francisco 22, Calif.)

Adult Golden Syrian hamsters, one hundred and five to two hundred and forty days old, were given 414 to 824 r whole-body irradiation in a single exposure (250-kv constant potential x-rays; h.v.l. 1.6 mm. Cu; average tissue-dose rate, ~30 r/min.). No significant difference in the reaction of the sexes was observed. Ninety-six per cent of the deaths during the first six weeks post-irradiation occurred prior to the twenty-eighth day.

For the pooled data, the estimated values of the LD 50/40 and the slope function, S, of the probit-transformed dose-effect (killing) curve were 611 r and 1.13, respectively. The relation between *log killing time* and *tissue dose* was linear for doses of 85 to 135 per cent of the LD 50. For the LD 15–LD 99 range, the death-rate curves had two peaks, a major one at eight to eleven days and a minor one at sixteen to nineteen days after irradiation, suggesting the existence of two different modes of death.

Recovery from an average tissue dose of 322 r was 18 per cent three days after exposure and 65 per cent seven days after exposure, as determined with a two-exposure technic. The rate of recovery was not an exponential function of time during this period. The best estimate of the time for 50 per cent recovery was approximately six days.

Seven figures; 1 table.

**Calorimetric Determination of the Power in a 1400 kv X-Ray Beam.** John McElhinney, Bernard Zendle, and Steve R. Domen. Radiation Res. **6:** 40–54, January 1957. (B. Z., Diamond Ordnance Fuze Laboratory, Washington, D. C.)

A calorimetric determination of the power in a 1,400-kv x-ray beam is described. Most of the x-ray beam power was absorbed in a thermally isolated lead cylinder, 4 cm. in diameter and 7.5 cm. long, resulting in a measurable rise of the temperature in the cylinder. The calorimeter was calibrated by dissipating a known quantity of electric power in the cylinder. Various corrections were applied to account for the beam power that was not absorbed by the cylinder.

A comparison was made between simultaneous measurements with the calorimeter and a graphite-walled ionization chamber. The ionization collected was proportional to the beam energy in units of roentgens-sq. cm. The result of this comparison gave a value of 2,983 ± 69 ergs per sq. cm per roentgen, which is in good agreement with a theoretical value of 2,985 ergs per sq. cm. per roentgen.

Seven figures; 6 tables. AUTHORS' ABSTRACT

# INDEX TO VOLUME 69

## N

**X-Y-Z**